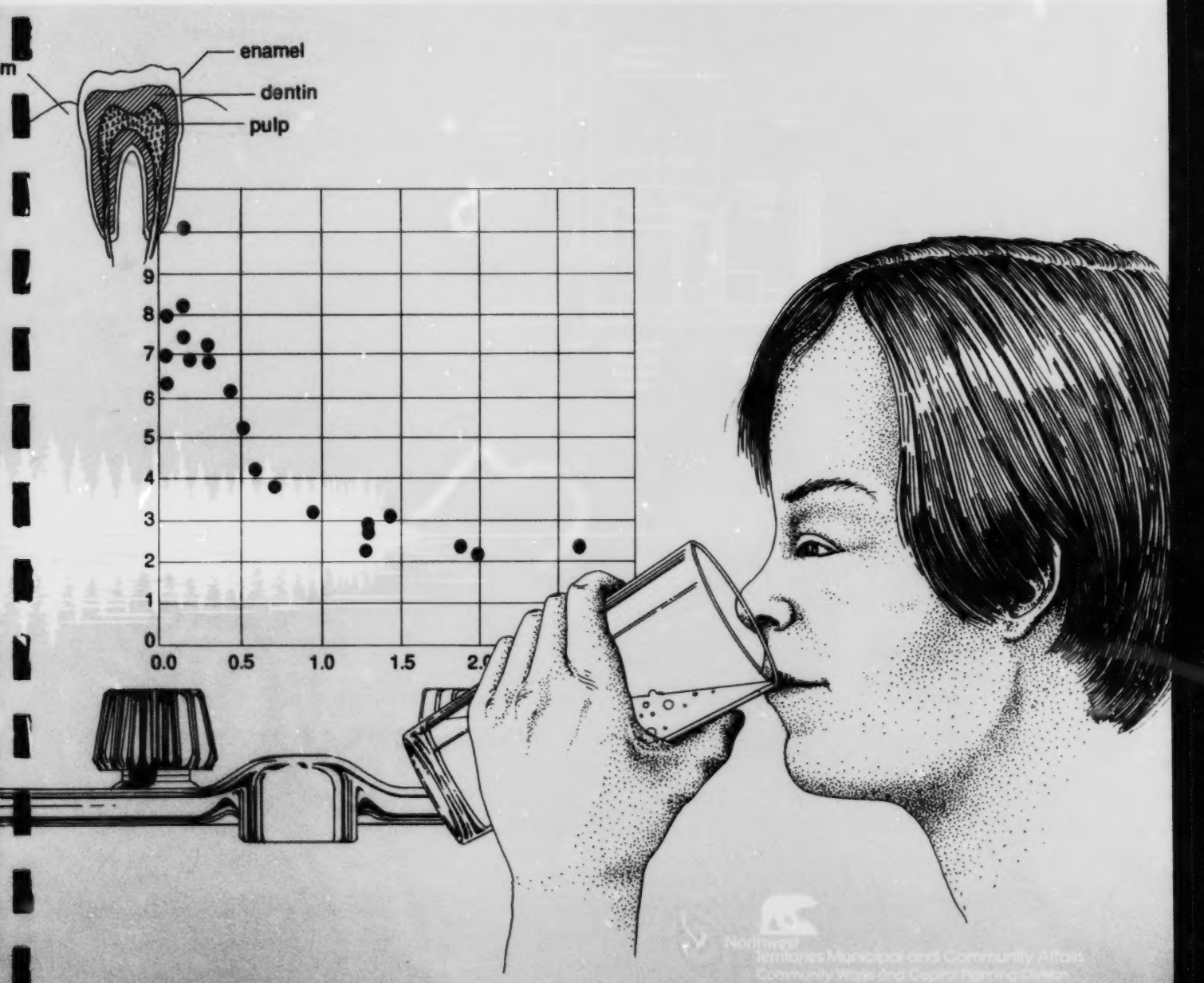
Dental Health and Fluoridation
in the Northwest Territories

by C.C. Marianayagam, M.L. Murray and G. W. Heinke



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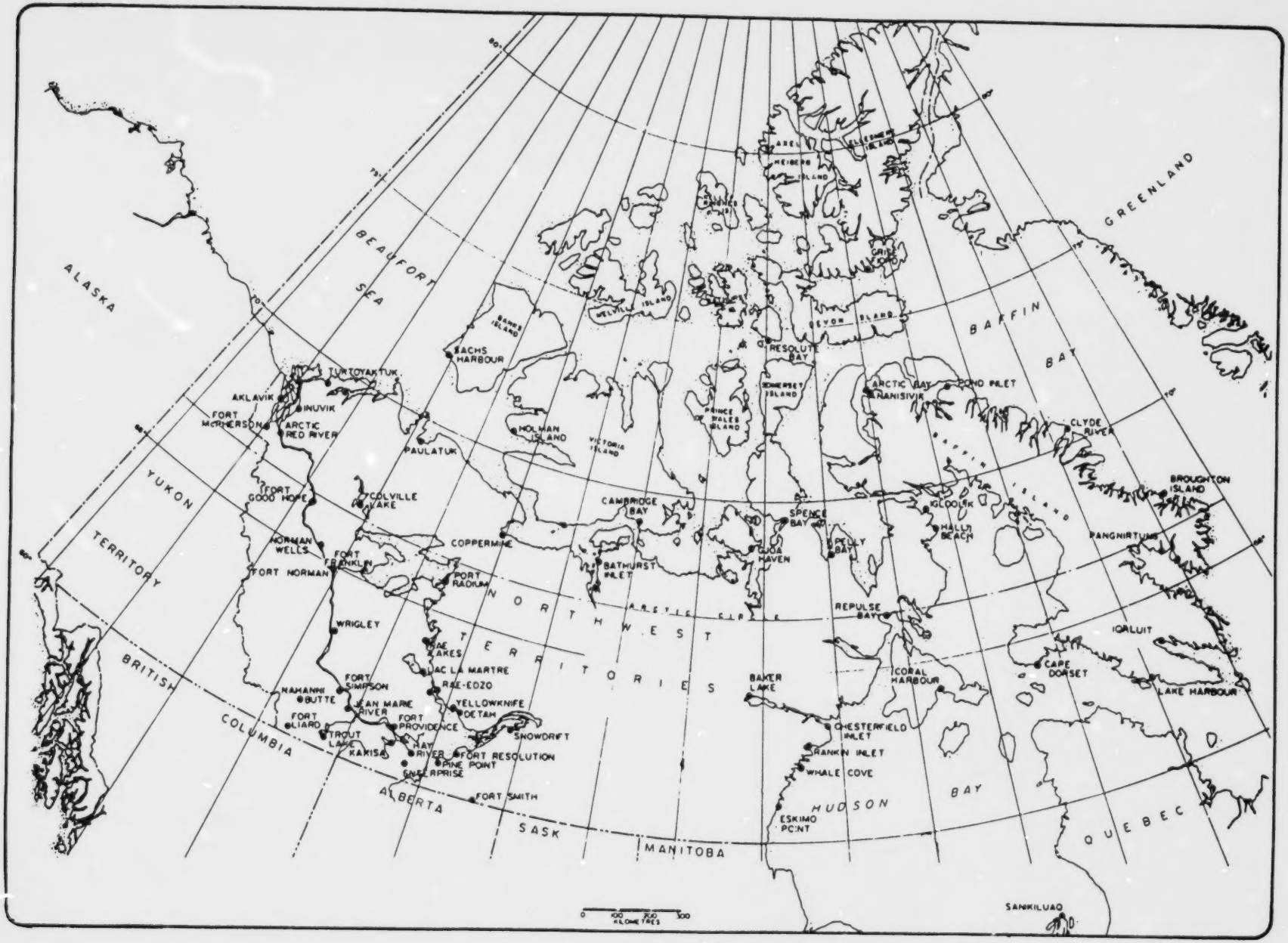
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BAKER LAKE
CORAL HARBOUR
CHESTERFIELD INLET
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SANIKILUAQ
0 100 200 300 KILOMETRES

DENTAL HEALTH AND FLUORIDATION IN THE NORTHWEST TERRITORIES

A research report prepared by

C. C. MARIANAYAGAM, M. L. MURRAY and G. W. HEINKE

For

The Department of Municipal and Community Affairs
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About the Authors:

Dr. Gary W. Heinke, P.Eng., is Professor of Civil Engineering and Dean of the Faculty of Applied Science and Engineering at the University of Toronto. He was engaged by the Government of the N.W.T. to carry out the study and supervised Cam Marianayagam's and Mike Murray's work.

Cam C. Marianayagam is Project Engineer, UMA Engineering Ltd., Edmonton, Alberta. He was formerly a graduate student in the Department of Civil Engineering at the University of Toronto.

Mike L. Murray is Manager, Reid Crowther & Partners Ltd., Inuvik, N.W.T. He was formerly a graduate student in the Department of Civil Engineering at the University of Toronto.

Executive Summary

The poor state of dental health and the high incidence of tooth decay in the Northwest Territories (N.W.T.), particularly among native people, is a cause for considerable concern. Tooth decay can be reduced by a combination of good nutrition, improved oral hygiene and the use of fluoride supplements. There are numerous methods of supplementing the normal dietary intake of fluoride. The most equitable, effective and efficient method is to add a controlled amount of fluoride to community water supplies. Although N.W.T regulations recommend that community water supplies be fluoridated, only 4 communities currently practice fluoridation. Because of the variety of water supply systems in the N.W.T., various techniques of water fluoridation are required.

This report discusses the current status of dental health in the N.W.T., the existing prevention and treatment programs, and examines various approaches to water fluoridation, compatible with the different water supply and distribution systems found in the N.W.T.. In communities with conventional water treatment plants, fluoridation can be easily implemented using conventional technology. In those communities with partial water treatment (disinfection only), and no year-round reservoir storage, fluoridation is recommended only if the fluoride concentration can be effectively monitored prior to distribution (trucked or piped). Finally, in those communities with year-round reservoir

storage, it is recommended that fluoride be added annually, during the reservoir filling. The design and implementation of such a "batch fluoridation" system is also discussed.

Several alternatives to water fluoridation are also investigated, including: salt fluoridation, milk fluoridation, school water fluoridation, fluoride tablets or drops, and topical fluoride treatments.

Finally, recommendations are made which aim to improve the dental health of residents of the Northwest Territories.

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1.0 BACKGROUND

The poor state of dental health and the high incidence of tooth decay in the Northwest Territories, particularly among native people, is a cause for considerable concern. Dental caries is the wide-spread, multi-factorial disease which causes most tooth decay. It is best countered by a combination of good nutrition, improved oral hygiene and the use of fluoride supplements.

Fluoride helps to prevent tooth decay in several ways: by increasing the resistance of tooth enamel to decay, by increasing the rate at which teeth mature, and finally, by helping to remineralize tooth surfaces which have started to decay. The normal dietary intake of fluoride can be supplemented in several ways, to enhance caries protection. The most equitable, effective and efficient method is to add a controlled amount of fluoride to community water supplies.

Since 1968, N.W.T. regulations have recommended that community water supplies be fluoridated. However, for a variety of reasons, only four communities currently practice water fluoridation. This is due, in part, to the diversity, and relative lack of sophistication of northern water supply systems. Because of the variety of water supply and distribution systems in the N.W.T., various techniques are required for water fluoridation.

This report, which examines dental health, water fluoridation and other fluoride supplements in the N.W.T., is the result of work done in 1986 and 1987 by reseachers at the University of Toronto. It is based primarily on a more detailed report by Marianayagam (1986). His report provided an extensive review of the relevant literature, and detailed information on a number of related topics. He also discussed fluoride supplements, and presented alternative approaches to water fluoridation, compatible with a variety of water supply systems.

Subsequent work by Murray (1987) examined, in more detail, the fluoridation of water supply reservoirs in the N.W.T.. His work is described in a report by Murray and Heinke (1988), and is also summarized herein.

2.0 DENTAL HEALTH IN THE N.W.T.

2.1 Current Dental Health Status

Several studies have documented the alarming prevalence of tooth decay (primarily caused by dental caries) among the native people of the Northwest Territories. Mayhall (1984) claimed that "By any measure of oral health .... dental caries and periodontal disease are probably the most prevalent diseases of arctic residents". Although no complete, systematic assessment of dental health in the N.W.T. has ever been performed, various researchers have studied dental health in the Keewatin and Baffin regions.

The lack of comprehensive dental health survey information is regrettable. In the absence of such information, it is difficult to:

- determine whether dental health varies between regions in the N.W.T.,
- determine dental health trends over time,
- determine the effectiveness of dental health care programs, and,
- make valid comparisons with dental health in the rest of the country.

It is hoped that baseline dental health surveys will be conducted across the N.W.T. in the near future.

The dental health status of a population is often measured using several indicators. The "deft" index refers to the primary (or deciduous) teeth, and records the number of decayed, extracted,

filled teeth. An alternative for the primary teeth is the "dft" index, which records only the number of decayed, filled teeth. The deft index is generally larger than the dft index for a given population. The comparable measure for permanent teeth is the "DMFT" index which indicates Decayed, Missing, Filled (permanent) Teeth. These indices are commonly used in the dental literature and will be referred to extensively in the following discussion.

Two dental health surveys of communities in the Keewatin region are summarized in Table 2.1. Although the studies differed somewhat in their sample sizes and methodologies, they provide considerable information. It appears that the incidence of dental caries has increased in the 15 year period spanned by the two surveys. The results indicate a very high rate of tooth decay in young children. At age 5, a child generally has 20 primary teeth. Hence, a deft of over 10 at age 5 (shown in both surveys), indicates that more than half of the teeth have experienced some decay. Thus, at age 5 - 6 the vast majority of children enter school with at least half of their primary teeth decayed, missing or filled due to caries activity. McPhail et al. (1972) indicated that 79% of the 5 year old group and 82% of the 6 - 7 year old school population were afflicted with dental caries. Average DMFT indices of 0.86 and 2.26 for 5 and 6 year old children (McDonald, 1985) suggest that permanent teeth begin to decay shortly after eruption.

TABLE 2.1

KEEWATIN REGION DENTAL HEALTH SURVEYS

AGE	(1) Curzon and Curzon (1969)			(2) McDonald (1985)		
	deft	DMFT	deft+DMFT	deft	DMFT	deft+DMFT
5	10.7	?	?	10.92	0.86	11.78
6	10.9	?	?	9.65	2.26	11.91
7	8.5	1	9.5	8.62	3.88	12.5
8	7.2	2.6	9.8	6.18	4.4	10.58
9	5	2.5	7.5	3.61	5.61	9.22
10	2.5	3.4	5.9	2.19	6.62	8.81
11	?	4.4	?	0.67	8.99	9.66
12	?	5.1	?	0.34	10.74	11.08
13	?	5	?	0.07	12.48	12.55

NOTES:

(1) survey of 226 Inuit children in 7 Keewatin communities

(2) survey of 944 Inuit children in 7 Keewatin communities

TABLE 2.2

BAFFIN REGION DENTAL HEALTH SURVEY

(Clark, 1986 and Stamm, 1986)

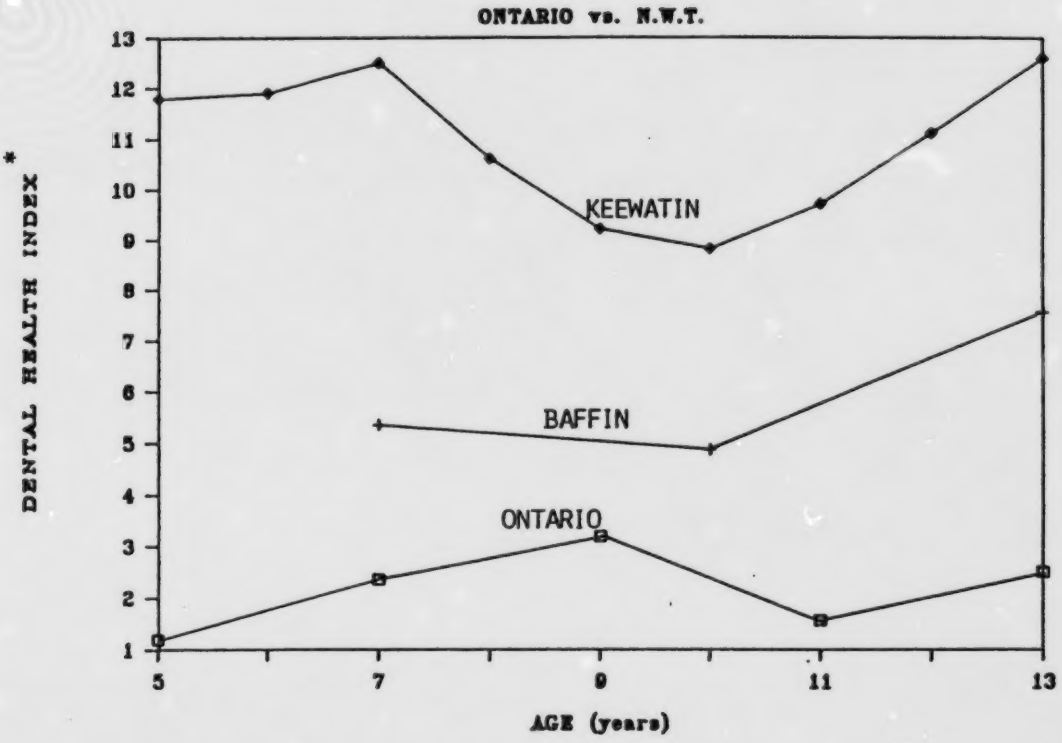
AGE GROUP	dft	DMFT	dft+DMFT
6 - 8	4.03	1.32	5.35
9 - 11	1.35	3.51	4.86
12 - 14	0.11	7.43	7.54

NOTE: Survey of 1456 Inuit children

Results of a dental health survey of Baffin region communities by the Faculty of Dentistry at McGill University (Clark, 1986 and Stamm, 1986) are summarized in Table 2.2. The results indicate less tooth decay in the Baffin than in the Keewatin region. However, in the Baffin study the dft index for deciduous teeth was used instead of the deft index. The results in Table 2.2 would undoubtedly be greater, and hence closer to the Keewatin results, had extracted teeth been included in the survey.

The results from Table 2.2 and the results of the McDonald (1985) Keewatin study are compared with dental survey results from Ontario for the year 1986 (Ryan, 1987), in Figure 2.1. The figure shows clearly that the incidence of dental caries is higher in both N.W.T. regions, than in Ontario, for all age groups. As mentioned earlier, the Baffin results might be greater, had deft, rather than dft been used as the dental health index. This comparison highlights the relatively poor state of dental health in the N.W.T.

It is also interesting to compare these results with the dental health goals proposed by the World Health Organization (1980) for the year 2000. There are six such goals, but two of them are most illustrative. First, 50% of all 5 to 6 year old children should be caries-free by the year 2000 (i.e. deft + DMFT = 0). Second, the average number of decayed or filled teeth should be no more than three per individual 12 year old. It is clear that



* Dental Health Index
= deft + DMFT for Ontario and Keewatin
= dft + DMFT for Baffin

FIGURE 2.1

COMPARISON OF DENTAL HEALTH SURVEYS

much remains to be done to reach these dental health goals in the N.W.T.

The relatively high incidence of tooth decay among native people in the north is due to many complex factors. It is most often attributed to a change from the traditional Inuit diet of caribou, seal, fish, flour and tea to a diet high in refined carbohydrates. This shift was particularly prevalent among young people, who now consume large quantities of candy bars, snack foods and canned soft drinks (Mayhall, 1977). For example, Schaefer (1971 and 1978) reports that in the Pangnirtung, Cumberland Sound trading area, estimated per capita consumption of refined carbohydrate in the form of sugar increased by 400 per cent over an eight year period - from 26 lbs in 1959 to 104.2 lbs in 1967. This represented a change from 18.1% to 44.2% of the total carbohydrate consumed. Interestingly enough, it took over a century for Western nations to increase their consumption of refined carbohydrate to almost 50% of the total carbohydrate intake. In many instances however, the native people have achieved this in only one or two decades!

The prevalence of tooth decay among very young children often results from a condition known as "baby bottle caries". It is common for native babies to be given bottles of highly sweetened fruit drinks or milk, to suckle for long periods of time. The

high sugar content contributes to the rapid decay of the immature teeth.

Other possible factors contributing to the higher caries incidence may include oral hygiene practices, the time of tooth emergence, crown and root morphology (Mayhall, 1977), availibility of dental care, and cultural differences (Mayhall and Stamm, 1984). The dental health of the Inuit and Indians has deteriorated to such an extent that, according to Schaefer (1978), " Even though their parents and grandparents had or still have excellent teeth, worn down perhaps by hard chewing but firm and without caries, today's children have mouths that are graveyards of rotten stumps.....".

2.2 Dental Services

The provision of dental services in the Northwest Territories falls under the auspices of Medical Services Branch (MSB), Health & Welfare Canada and the Department of Health of the Territorial Government. Services are provided by private dentists and dental therapists. The organization and distribution of dentists in the Territories is detailed in Table 2.3, while that of dental therapists is shown in Table 2.4.

The number of visits made by dental therapists to their satellite communities varies depending on the size of the

TABLE 2.3

ORGANIZATION & DISTRIBUTION OF DENTISTS

IN THE NORTHWEST TERRITORIES (1986)

Zone	Population +	Dentists	Arrangement
Inuvik	8 228	4	Private dentists from Inuvik & Norman Wells contracted by MSB
Baffin	9 528	4	Employed by GNWT located at Frobisher Bay & Igloolik
Mackenzie *	28 424	11	Private dentists from Yellowknife, Hay River & Fort Smith contracted by MSB
Keewatin	4 832	1.72 person years	University of Manitoba contracted by MSB per diem basis

Source: Dr. G. Schnell, Regional Dental Officer, Medical Services Branch, Yellowknife, NWT.

+ & *: See explanation after Table 2.2.

TABLE 2.4

ORGANIZATION & DISTRIBUTION OF DENTAL THERAPISTS

IN THE NORTHWEST TERRITORIES (1986)

Zone	Population +	No. of Dental Therapists	Distribution	
			Base	Satellites
Inuvik	8 228	5	Inuvik	Sachs Harbour
			Aklavik	
			Ft. McPherson	Artic Red River
			Ft. Norman	Ft. Franklin
			Tuktoyaktuk	Paulatuk
Baffin	9 528	5	Pangnirtung	
			Pond Inlet	
			Arctic Bay	Nanisivik
				Clyde River
			Frobisher Bay	
			Cape Dorset	
Mackenzie *	28 424	7	Cambridge Bay	Holman Island
				Coppermine
			Snowdrift	
			Rae-Edzo	
			Ft. Smith	
			Ft. Simpson	
			Spence Bay	Gjoa Haven
				Pelly Bay
			Ft. Resolution	
Keewatin	4 832	3	Eskimo Point	
			Rankin Inlet	
			Baker Lake	

Source: Dr. G. Schnell, Regional Dental Officer, Medical Services Branch, Yellowknife, NWT.

* Mackenzie zone = GNWT Fort Smith (Popln. 24 790) & Kitikmeot (Popln. 3 634) zones.

\+ June 1985 estimate (GNWT, 1986)

community. Relatively small communities such as Sachs Harbour (pop. 161) see a dental therapist not more than twice a year. Larger communities such as Coppermine (pop. 887) may be visited three times a year. Efforts are made to visit each satellite community at least twice a year (Schnell, 1986).

The private dentists in the Inuvik and Mackenzie zones are contracted by Medical Services Branch to visit all communities in the two zones. The frequency and duration of visits to the communities are governed to a large extent by the population. Some of the relatively large communities, such as Cambridge Bay (pop. 902) are scheduled to be visited almost four times a year, by a dentist who is contractually obliged to provide up to a maximum of 8 working weeks/year of dental service. Small communities like Bay Chimo (pop. 65) are scheduled to be visited once a year, with the visiting dentist being contractually obliged to provide up to a maximum of 1 working week/year of dental service (Schnell, 1986).

In the Baffin zone, dental services are not directly under the control of Medical Services Branch but are the responsibility of the Department of Health, GNWT, the takeover having taken place on September 1, 1986. A contribution agreement however, does exist between Medical Services Branch and the Department of Health, whereby the former will provide professional support services when required by Department of Health personnel. In

addition, Medical Services Branch will work with the Department of Health on a regular basis regarding general health information, changes in standards and practices etc. (Berthelet, 1986). Dental services are provided on a periodic fly-in basis to all communities, by the GNWT dentists operating out of Iqaluit General Hospital. The recently appointed dentist at Igloolik currently caters for that community only (Berthelet, 1986).

Since being contracted in 1980 by Medical Services Branch, dentists from the University of Manitoba provide dental services periodically on a fly-in basis to all communities in the Keewatin Region. Schnell (1986) reports that the University dentists are contracted by Medical Services Branch to provide a maximum of 430 working days/year in dental services to the Keewatin. This is equivalent to 1.72 person-years for 1986 (Table 2.3).

It must be noted that dentists provide services on a fly-in basis to base/satellite communities where dental therapists are active (Schnell, 1986).

2.2.1 Role of the Dental Therapist

The National School of Dental Therapy was established in 1972 by the Federal Government (through Medical Services Branch, Health & Welfare Canada) in conjunction with the Faculty of Dentistry of

the University of Toronto. The School was initially located in Fort Smith, NWT, but relocated to Prince Albert, Saskatchewan, in 1982, because the relatively small population in the former was insufficient to maintain an adequate patient supply for the clinical component of the training program (Davey, 1986).

The dental therapist concept was designed with the sole objective of providing basic dental care to Canada's native people. It incorporates two functions: to train dental therapists, and to ensure that their performance in native communities conforms to standards established during the two-year period of training at the National School of Dental Therapy (Davey, 1980).

Dental therapists are employed exclusively by Medical Services Branch and currently provide primary dental care in thirty communities of the Northwest Territories (Table 2.4). They primarily serve the community where they are permanently located, but may also conduct one or more satellite field clinics in surrounding communities. The community of permanent location does tend to vary as therapists relocate or leave the workforce.

Dental therapists are not trained to examine or diagnose a dental condition, but work from prescriptions of treatment provided for them by their supervising dentists, who for the most part have been the staff dentists from the National School of

Dental Therapy. There are instances however, where treatment plans are prepared by private dentists, GNWT dentists in the Baffin or the Regional Dental Officer, Medical Services Branch (Schnell, 1986). For monitoring and treatment planning purposes, visits by supervising dentists from the National School of Dental Therapy are scheduled for each therapist at least twice a year. In addition, these visits ensure quality control, enable program evaluation and aid in monitoring the administration and treatment aspects of the dental therapy program (Davey, 1986).

2.2.2 Caries Preventive Programs

Caries preventive programs are currently being implemented on a continuous basis only in those communities with resident dental therapists. The preventive programs may be based either in the schools, or in the dental clinics. School-based programs include:

- a weekly fluoride mouthrinse program,
- individual toothbrushing demonstrations, and
- self-applied fluoride gel treatments (every six months).

The dental clinic programs involve:

- plaque/calculus (tartar) removal and pit/fissure sealants,
- nutritional advice to parents.

The school-based programs have the potential to reach, and benefit, many more children than the clinic-based programs, since many children rarely, if ever visit the dental clinic. However,

school-based programs have been hampered by several factors.

The first problem is that no time is officially allocated in the current Department of Education school curriculum for dental health education and preventive programs to be conducted by dental therapists. School officials are therefore under no obligation to incorporate dental health programs in the school curriculum. Although there has generally been good cooperation from education officials, time constraints do not always make it possible to implement all three school-based preventive strategies. Also, the level of cooperation varies from year to year with the turnover of school principals.

A possible solution to this problem is to incorporate preventive strategies such as fluoride mouthrinse or tablet programs, and dental health education as part of the school curriculum of the Territorial Department of Education.

Secondly, school-based preventive programs currently commence at the grade 1 level (Schnell, 1986), in which children are at least 5 years old. Additional benefits would be obtained by starting preventive programs a year earlier, at the kindergarten level, where the children are at least 4 years old. Information provided by Crouch (1986) confirms that there are organized kindergarten classes in each of the 20 communities where there are resident dental therapists.

A third problem with the school-based programs is the poor attendance records of some children. During the most recent school year, some schools had over 90% attendance, many schools had between 60 and 80% attendance, and a few had between 50 and 60% attendance (Crouch, 1986). The lower the percentage attendance, the less successful will be the school-based preventive programs.

Those communities not served by resident dentists or dental therapists generally have few, if any, preventive programs. There are 35 such communities in the N.W.T., comprising almost 25% of the population. Although dental therapists and/or dentists may begin dental health education programs, school-based toothbrushing programs, and/or fluoride mouthrinse or tablet programs, there is often no continuity to these efforts in the absence of proper supervision and control.

The situation could be improved in several ways. One approach would see the dentist devote more time to preventive programs during the periodic community visits. However, this may be difficult to achieve, since services in this regard are not billable under current contractual agreements with Medical Services Branch (Schnell, 1986). Consequently, preventive services are being increasingly restricted to chairside (one-to-one) advice during the performance of treatment services.

Expansion of the Dental Therapy Program might also alleviate some of the problems, since resident dental therapists could maintain the continuity of preventive programs. Although the School of Dental Therapy has the facilities to train more therapists, expansion of the Dental Therapy program is not expected in the near future, given the current financial constraints (Schnell, 1986).

As will be discussed in the next section, fluorides are most effective in combatting dental caries if sufficient amounts are ingested by children from about 3 months after birth to about 8 years of age. The current school-based programs, mentioned previously, only reach children 5 years of age, and older. Far greater benefits would be expected, if the preventive programs could reach younger children. There are several possibilities for this, regardless of the presence of a dentist or dental therapist.

The first possibility would involve initiating preventive programs in well-baby clinics operated by the community nursing stations. These clinics provide post natal care (e.g. immunization, height/weight measurements, etc.) to children for a period of approximately four years after birth. Although fluoride supplementation programs could be implemented easily at the well-baby clinics, the nurses in many nursing stations are already overworked, and would not welcome the additional

responsibilities. In those communities where there is a dental clinic, the nurse could direct the mother and child to the dental therapist/dentist for the fluoride supplement component of the well-baby clinic.

A second possibility would be to establish preventive programs in daycare centres. These centres are under the jurisdiction of the Department of Social Services of the Territorial Government (Wilson, 1986). There are currently 24 organized daycare centres (serving approximately 800 children) in the Northwest Territories. Although the majority of them are located in the larger centers, such as Yellowknife, Inuvik, Hay River and Iqaluit, several smaller communities (e.g. Baker Lake, Rankin Inlet, Nanisivik and Cambridge Bay) also have facilities. Children in daycare centres generally range in age from 2 to 5 years, although some may be considerably older. Wilson (1986) does not forsee any objections from the Department of Social Services in the introduction of fluoride supplement programs in daycare centres.

Preventive efforts must continue to be directed towards mothers of pre-schoolers because of the serious problem of "baby-bottle caries" in these children. As stated earlier, this is a condition of rampant decay in the primary dentition caused by prolonged bottlefeeding during the daytime and at bedtime with sugar-sweetened juices and milk. Unlike southern Canadian

communities, the "extended family" system is very strong among the native people. It is not uncommon therefore for a native child to be cared for by other family members (e.g. grandparents, aunts, uncles etc.) Discussions with the dental therapist in Rankin Inlet indicate that while it may be possible to convince the childs' mother of the adverse effects of prolonged bottle-feeding, the fact that the child spends considerable time with others makes it difficult for the mother to have any control over this destructive practice (Onalik, 1986).

Dental health education and promotion materials appropriate for native people must continue to be developed. These must be produced in dialects which can be understood and must reflect native culture and identity, lifestyles and values.

The preventive programs currently in place need to be evaluated to determine their effectiveness so that they can be modified if existing strategies are proving ineffective. However, this evaluation requires a data base with appropriate indices which are capable of measuring the effectiveness of the preventive strategies.

3.0 FLUORIDE AND DENTAL HEALTH

3.1 The Role of Fluoride in Caries Prevention

There is a very extensive dental literature regarding the role of fluoride in caries prevention. This section is not intended as a literature review, but rather is intended to provide background information necessary to indicate the advantages of water fluoridation in the N.W.T. For more detailed information, the reader is referred to the recent report by Marianayagam (1986) or to works by Newbrun (1986), Mellberg and Ripa (1983) or Murray and Rugg-Gunn (1982).

Before discussing the role of fluorides in the prevention of dental caries, it is necessary to briefly describe the nature of the disease itself. Dental caries begins with the formation of acid by microorganisms in the layer of plaque (sticky substance composed of saliva and tiny bits of food residue) overlying the tooth enamel. The acid acts to dissolve the tooth enamel, creating a cavity in the tooth surface (tooth decay). It is a localized, multifactorial disease requiring the simultaneous presence of three factors:

(1) microorganisms,

(2) a diet for the microorganisms, and

(3) a susceptible host or tooth surface

(Mellberg and Ripa, 1983). In the absence of any of these factors, caries will not develop.

The caries-producing bacteria ferment carbohydrates, producing lactic and other acids capable of dissolving tooth enamel. The plaque layer is significant, since it holds the microorganisms and acid against the tooth surface. Sucrose is the major cariogenic (caries producing) food item, since it is used both in forming the plaque layer, and in the production of acids by microorganisms. Caries usually develops during the first 2-3 years after a tooth's eruption.

The caries process can be curtailed in several ways. First, improved oral hygiene can reduce the number of cariogenic bacteria or disrupt their ability to metabolize fermentable carbohydrates. Secondly, reducing the dietary intake of sucrose will reduce the substrate available for bacterial action. Finally, the ability of the tooth to withstand caries attack can be enhanced by the ingestion of the proper amount of fluorides.

Evidence suggests that fluoride provides anticaries action in several ways, and that several mechanisms may function simultaneously. Fluoride can modify, or eliminate each of the three factors previously mentioned as necessary for caries formation. Some contributions of fluoride to caries resistance include:

(1) increased enamel resistance,

(2) increased rate of tooth maturation, and

(3) remineralization of enamel.

Each of these mechanisms is described briefly below.

Tooth enamel is composed largely of hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$). Fluoride ions can replace the hydroxyl (OH^-) ions to form fluorapatite ($Ca_{10}(PO_4)_6F_2$), a less soluble mineral, more resistant to acid attack. When teeth are formed, they acquire an amount of fluoride in the surface enamel reflecting the amount of fluoride ingested via food or water. High enamel fluoride levels are found to be related to low caries prevalence.

As mentioned earlier, caries generally attack teeth shortly after eruption. The resistance of teeth to caries increases with time after eruption. One reason for this phenomenon is that newly erupted tooth enamel has areas where mineral deposition is incomplete (hypomineralized areas), and hence susceptible to caries attack. These areas generally become fully mineralized within a few months after eruption. It has been shown that "hypomineralized areas that mature in the presence of fluoride should contain more fluoride than enamel that was fully mineralized on eruption" (Mellberg and Ripa, 1983). Furthermore, fluoride may increase the rate of mineralization, and hence decrease the period during which teeth are most susceptible to caries.

The early stages of caries attack on a tooth involves the dissolution of the enamel mineral in a cariogenic environment

(i.e. under a plaque layer). If the environment is altered, possibly by removal of the plaque layer, the caries attack may be arrested. Repair of minor caries damage involves a process of remineralization whereby the tooth enamel is regenerated. In the presence of fluoride (from the oral environment), the remineralized enamel may be higher in fluorapatite than the surrounding enamel, and may acquire increased caries resistance.

Optimum protection against dental caries is achieved when children and infants ingest adequate amounts of fluoride during the period of tooth development. The primary ("baby") teeth mineralize between 4 month gestation and the age of one year. Mineralization of the permanent teeth begins 3 - 4 months after birth and is essentially completed by age 8 years (except for the third molars). Hence, fluoride ingestion is most beneficial from birth to the age of 8.

Fluoridation does not just benefit children, but also provides lifelong dental benefits for adults (Striffler et al., 1983). Benefits in adult life include greater tooth retention, reduced incidence of root caries and reduced bone fragility (osteoporosis) in elderly persons.

3.2 Sources of Ingested Fluoride

Fluorine, like chlorine, a gaseous halogen, is never found in

the free state. It always occurs in combination with other elements as fluoride compounds (Nikiforuk, 1985). In water solution, these compounds dissociate into ions, and it is these fluoride ions which are analytically determined and are the form in which fluorine is assimilated by humans (EPA, 1974). The physiological action of fluoride ions, from either natural or artificial sources, is identical (RCDS & ODA, 1960).

Fluoride can be ingested via drinking water,or from a number of other sources, including certain foods, cooking utensils, toothpastes, mouthrinses and fluoride tablets. Water, naturally or artificially fluoridated, is the most important single source of fluoride. However, fluoride in food also contributes significantly to the total fluoride intake.

Of commonly consumed vegetables, spinach has the highest amount of fluoride. Among animals, fish and other marine organisms contain the most fluoride. Some food additives like baking powder, gelatin, bone-meal and fish protein concentrate are potent sources of fluoride (Kumpulainen & Koivistoinen, 1977).

The use of fluoridated water during food processing can significantly increase the fluoride content of certain foods. Marier & Rose (1966) showed that certain foods prepared with fluoridated water have 3-5 times the concentration of fluorides found in foods processed with non-fluoridated water. A large

proportion of Canadian food-processing plants use fluoridated water in food processing.

An interesting finding is that tea contains high fluoride levels regardless of the water used in brewing. Tea brewed with non-fluoridated water contains approximately 0.9 ppm fluoride, as fluoride ions. If water with a concentration of 1 ppm fluoride is used to brew the tea, the resulting brew contains 1.5-2.0 ppm fluoride (Singer & Ophaug, 1978). The concentration of fluoride in tea prepared from tea bags depends on the period of immersion of the bag in hot water. It is important to note that in communities of the Northwest Territories where there is a significant consumption of tea, fluoride ingestion will be markedly affected.

Rao (1984) has conducted an excellent review of world literature on the fluoride content of foods and beverages, and is recommended reading for further information.

Cooking methods also affect fluoride levels. For example, the use of those cooking utensils coated with teflon, a fluoride polymer (to ease cleansing), may release fluoride into water or foods during cooking (Singer & Ophaug, 1978). Aluminium pots on the other hand, tend to remove fluoride from water used in food preparation. The use of pyrex and stainless steel vessels does

not significantly change fluoride levels of water used in cooking (Full & Parkins, 1975).

The fluoride intake, especially of children, is further affected by the possible ingestion of fluoridated toothpastes (dentrifices) and mouthrinses. Most fluoride toothpastes commonly used by the public contain approximately 1000 ppm fluoride in the form of sodium monofluorophosphate, sodium fluoride or stannous fluoride (Manji, 1983 and Lyon, 1985). It has been shown that children aged 2 to 13 years may swallow up to 35% of the toothpaste used (equivalent to 0.3 mg of fluoride). It would appear that the tendency to swallow toothpaste decreases with increasing age, with children aged 2-4 years ingesting the most. A significant amount of mouthrinse is also swallowed by young children. Ericsson & Forsman (1969) attributed this to the fact that the swallowing reflexes of children aged 3 years and under are inadequate to prevent ingestion of the solution. Further, they recommend that fluoridated mouthrinses should not be used in children under 4 years of age.

The total intake of fluoride by adults living in a Canadian community with a fluoridated water supply has been estimated to be between 2 and 5 mg/day. The fluoride intakes from both food and water, of urban populations in the United States, ranged from approximately 1 mg/day in low fluoride regions to 4 mg/day in

those with a fluoridated water supply (Health and Welfare Canada, 1983).

Even though fluoride-containing food, water and other beverages are ingested, what is of importance is the ultimate amount of fluoride absorbed by the body. Studies by others indicate that the site of fluoride absorption in humans is the entire gastro-intestinal tract (WHO, 1970). Fluorides ingested in foods are not as completely assimilated as are fluorides in water. Over 85% of the fluoride in water is absorbed, whereas only about one third to one half of fluoride in foods is assimilated (Nikiforuk, 1985).

Continuous ingestion of above optimum amounts of fluoride can produce a condition known as dental fluorosis. This condition appears as mottling of the tooth enamel. It can range from very mild, with a few opaque white areas, to severe cases in which entire teeth are pitted and/or stained brown. This condition was first noticed in communities with very high natural concentrations of fluorides in their drinking water.

4.0 FLUORIDE SUPPLEMENTS

The normal dietary intake of fluoride can be supplemented in several ways to enhance caries protection. The term "fluoride supplement" in this section will be used in a very general sense, to include all methods of increasing fluoride availability to the teeth. Fluoride supplements may be either systemic or topical. Systemic fluoride enters the body's digestive system via food, water or fluoride tablets and acts from the "inside-out". The fluoride is incorporated within the enamel of developing teeth, providing maximum caries resistance. Topical fluoride works from the "outside-in". Topical fluoride treatments are applied directly to teeth as solutions, gels, varnishes, or via the use of toothpastes (dentrifices). Because topically applied fluorides do not penetrate deeply into the enamel, they tend to provide only local protection at, or near, the tooth surface (Newbrun, 1986). A variety of fluoride supplements are described in more detail in the following sections.

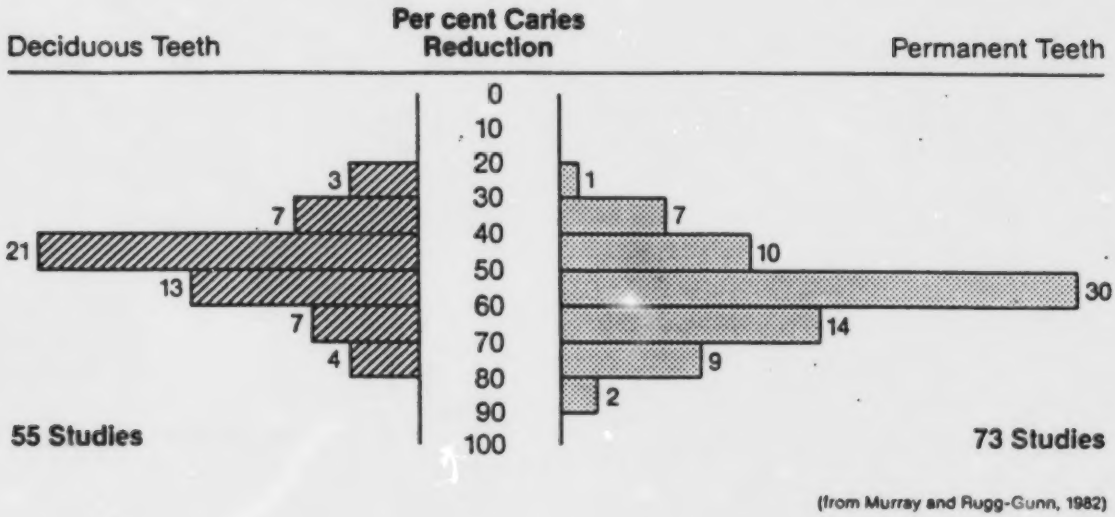
4.1 Water Fluoridation

From a public health perspective, an ideal fluoride supplement should benefit the entire population of a community, regardless of age, social class, economic status or access to dental care. Furthermore, it should be available during the critical period of tooth development (birth to 8 years), should be economical, and require minimum effort from those receiving the benefits. On the

basis of these and other criteria, numerous studies have concluded that fluoridating community water supplies, where possible, is the desired method of providing a systemic fluoride supplement. For example, the Royal College of Physicians in London (cited in Newbrun, 1986) concluded that "In comparison with (water) fluoridation, systemic fluoride supplements such as tablets, drops and fluoridized salt have not been shown to be as effective, on a community basis".

Controlled fluoridation of community water supplies to an optimum level results in approximately a 40 to 60% reduction in the incidence of dental caries. Figure 4.1 summarizes the caries reduction noted in 95 studies of the effectiveness of water fluoridation in 20 countries. The modal reduction in caries was 40 - 50% for the primary teeth and 50 - 60% for the permanent teeth (Murray and Rugg-Gunn, 1982).

As mentioned earlier, the recommended daily intake of fluoride is 1 mg for children over age 3. This can be obtained from 1 litre of water fluoridated to a concentration of 1 mg F/litre. Since the amount of water consumed by humans generally increases with increasing ambient air temperature, the optimum fluoride concentration also varies with climate. The optimum fluoride concentration ranges from 0.8 mg/L in warm climates to 1.4 mg/L in cold regions (such as the N.W.T.). The effect of fluoride concentrations on the incidence of dental caries is illustrated



(from Murray and Rugg-Gunn, 1982)

FIGURE 4.1

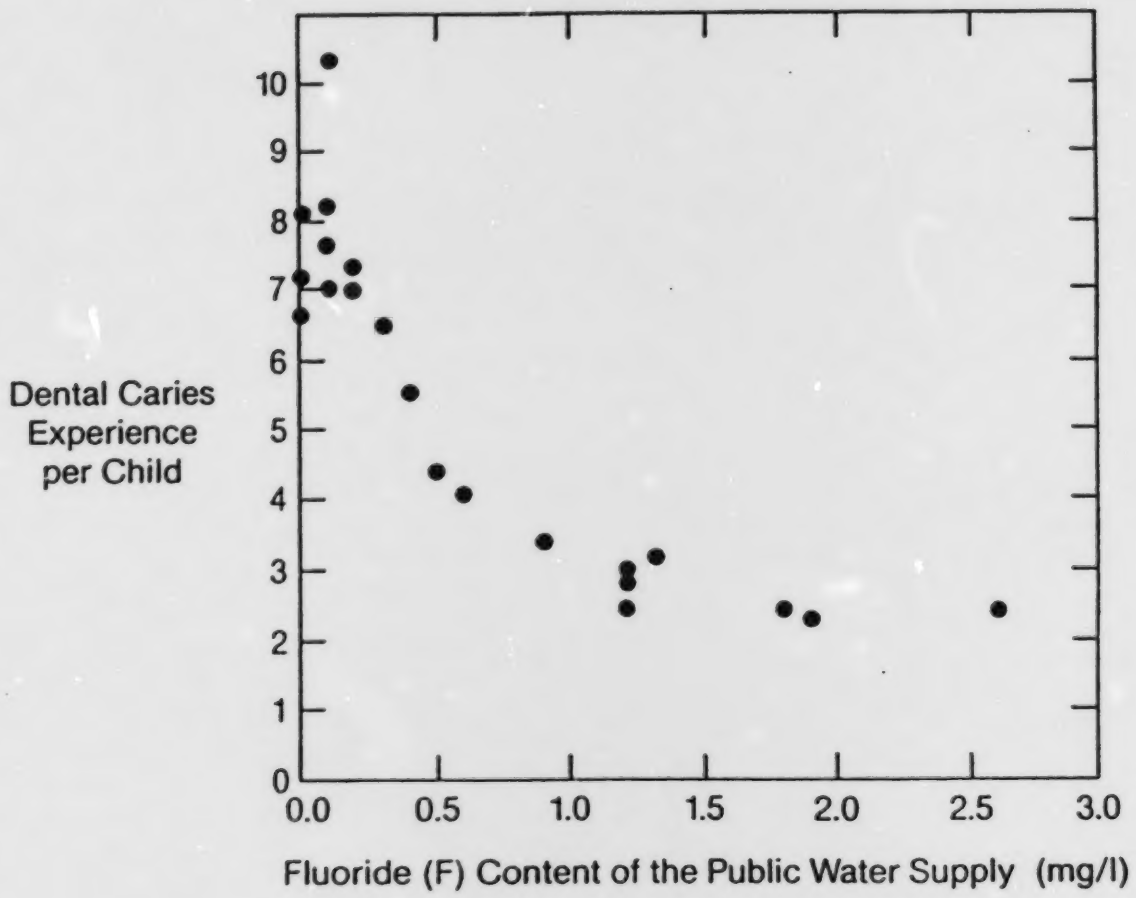
CARIES REDUCTION FOLLOWING WATER FLUORIDATION

(results of 95 studies in 20 countries)

in Figure 4.2 (Murray and Rugg-Gunn, 1982). These results, from a study in the U.S., indicate a dramatic reduction in caries incidence as the fluoride concentration increases to between 1.0 and 1.5 mg/L. Fluoride concentrations greater than about 1.5 mg/L do not provide any further significant caries reductions.

Approximately 300 million people worldwide consume optimally fluoridated water. Included in this estimate are about 100 million people in the United States, 30 million in the Soviet Union, and 10 million in each of Brazil, Columbia and Australia (CDA, 1984). The most recent national survey in Canada produced the results shown in Table 4.1. As indicated, approximately 9 million Canadians (37% of the population) were receiving the benefits of fluoridated water.

Despite the benefits of fluoride supplements described previously, and the cost effectiveness and efficiency of water fluoridation, it has been, and continues to be, a controversial issue. However, the controversy is really a social and political one, rather than scientific or technical. As the Consumer's Union (an American consumer advocate group) concluded (cited in Mellberg and Rippa, 1983) "There is no scientific controversy over the safety of fluoridation. The practice is safe, economical and beneficial. The survival of this controversy represents, in CU's (Consumer's Union) opinion, one of the major triumphs of quackery over science in our generation".



(from Murray and Rugg-Gunn, 1982)

FIGURE 4.2

THE EFFECT OF DRINKING WATER

FLUORIDE CONCENTRATION ON DENTAL CARIES

TABLE 4.1

POPULATION CONSUMING FLUORIDATED WATER IN CANADA BY PROVINCE, 1980*

Province or Territory	Pop. on controlled fluoridation	Pop. on natural fluoridation	Total	Percent of total pop.
Manitoba	688 321	2 300	690 621	65,0
Ontario	5 142 558	98 889	5 241 447	59,1
Yukon Territory+	13 781	238	14 019	54,0
Nova Scotia+	348 763	0	348 763	40,1
Alberta	765 515	55 911	821 426	39,6
Northwest Territories	19 280	0	19 280	37,0
Saskatchewan	301 199	2 852	304 051	33,2
British Columbia	324 135	0	324 135	27,5
Prince Edward Island	22 073	0	22 073	17,6
Quebec	1 101 750	19 373	1 121 123	17,4
New Brunswick	88 159	6 475	94 634	13,1
Newfoundland	44 253	2 563	46 816	7,9
Canada	8 859 787	188 601	9 048 388	36,9

* Population projections based on percentage change of population 1971-76, Canadian Year Book, 1978-79, Ministry of Industry, Trade and Commerce, 1978.

+ 1980 data unavailable, figures based on data from H & WC (1977) using 1980 population projections.

Source: CDA (1981)

4.1.1 Technology of Water Fluoridation

Water fluoridation can be implemented using various combinations of chemicals and feed mechanisms. Theoretically any chemical compound that forms fluoride ions in solution can be used for water fluoridation. The three most commonly used compounds are sodium fluoride (powder), sodium silicofluoride (powder) and hydrofluosilicic acid (liquid). Historically, the first two chemicals were widely used, but more recently, hydrofluosilicic acid use has increased, for several reasons: (Mellberg and Ripa, 1983)

- it can be used with simple feed equipment (positive displacement chemical feed pumps),
- small water supplies can be easily fluoridated using only a dilution tank and transfer pumps,
- chemical handling is uncomplicated, and
- cost is low.

The chemicals are added to the water by means of a feeder, a mechanical device which measures out quantities of the chemical and introduces them to the water . Feeders are either solution or dry types depending on whether the chemical is a liquid or a solid. In either case, the chemical is in solution form when it is administered to the water supply. Dry feeders are further sub-divided into two categories, volumetric and gravimetric, depending on whether the chemical is measured by volume or weight.

The fluoride must be administered (by pressure or gravity feed) at a point through which all the water to be treated passes. It is generally added near the end of the water treatment process.

4.1.2 School Water Fluoridation

Fluoridating school water supplies is considered an effective way of providing the benefits of fluoride to children residing in communities without public water supplies (Horowitz, 1983). The concentration of fluoride in the school water supply must be considerably higher than the optimum recommended for community fluoridation. This approach is necessary to compensate for the intermittent exposure of children to fluorides in a school water fluoridation program. Horowitz (1973) considers that fluoridation of school water supplies to a level four and a half times that recommended for community fluoridation will significantly reduce the incidence of dental caries, without the occurrence of dental fluorosis. However, school water fluoridation is not advisable in those communities where the school staff housing is on the same water distribution network as the school itself. The higher than optimum fluoride level in the water could result in the ingestion of high levels of fluoride by staff housing occupants.

Apart from the need to maintain a higher fluoride level, the technical aspects of school-water fluoridation are very similar to those of community water fluoridation. Horowitz (1973) notes

two major problems that have arisen out of the practice of school-water fluoridation : equipment maintenance and monitoring of fluoride levels. It is of the utmost importance that both procedures be conducted regularly and conscientiously. Furthermore, fluoridation systems should not be installed in schools supplied by a variable flow water supply. The technical problems encountered in ensuring a uniform fluoride level in a variable flow system are often too complicated for school authorities to handle.

4.2 Other Systemic Fluoride Supplements

4.2.1 Fluoride Drops and Tablets

In the absence of a fluoridated community water supply, systemic fluoride supplements may be provided via fluoride drops or tablets. For maximum benefit, such fluoride supplement programs should commence with children shortly after birth, and continue until about the age of 12 or 13. For very young children, fluoride drops may be added to baby formula or food. Chewable tablets are the most popular supplement for older children. Because they are chewed, these tablets provide both a topical effect (while they are in the mouth), and a systemic effect (after the pieces are swallowed). The required fluoride dose varies with age, and also varies with the background fluoride concentration in the drinking water. A recommended dosage schedule is presented in Table 4.2.

TABLE 4.2

RECOMMENDED DAILY DOSAGES OF FLUORIDE SUPPLEMENTS ACCORDING TO AGE & NATURAL FLUORIDE CONTENT OF WATER

Natural F content of water (mg/L)	Daily dosage of fluoride ion (mg)		
	Birth to 2 yrs	2-3 yrs	> 3 yrs
0-0,3	0,25	0,50	1,00
0,3-0,7	0	0,25	0,50
over 0,7	Fluoride supplements not recommended		

Adapted from Canadian Dental Association Guidelines for use of fluoride supplements entitled "Fluoride Supplements for Prophylaxis of Dental Caries", by G. Nikiforuk, 1980.

Fluoride drop or tablet programs can be very effective in reducing caries, provided that the supplements are ingested daily, from shortly after birth until the age of 12 or 13 years. This level of compliance requires considerable motivation, dedication and perseverance, from both parents and children. The necessary products must also be readily available. Numerous studies have shown very disappointing compliance rates in unsupervised fluoride supplement programs (Newbrun, 1978). Such results ranged from only 25% continued use after 1 year, to 5% use after 5 years. There is little reason to believe that such programs would be any more successful in the N.W.T..

School-based programs have also been implemented, to try to improve the compliance rates. These programs are generally easy to implement, and require little effort on behalf of the teachers or students. However, they do require constant promotion by public health personnel, since compliance tends to wane over time. Constant cooperation by the school system is also required. Another drawback is that these programs do not benefit children during the times they are not in school, nor those younger than school age.

4.2.2 Salt Fluoridation

The addition of fluoride to salt is considered an efficient way of bringing the benefits of systemic fluoride to communities that are inaccessible to piped water (Striffler, Young and Burt, 1983). Nikiforuk (1985) reports that it was the successful supplementation of salt with iodine, for the prevention of goitre, that paved the way for the introduction of fluoridated salt. Fluoridated salt was first used in Switzerland in 1955, as the mountainous terrain of that country prevented many communities from having municipal water supplies. The reduction in caries incidence in communities using fluoridated salt consistently paralleled that found in communities having water fluoridation (Marthaler et al, 1978). The Advisory Committee of the Canadian Public Health Association recommended in 1979 that the safety and efficiency of using fluoridated salt to

supplement fluoride intake in areas with fluoride-deficient drinking water, be investigated. Jamieson (1986) reports that no such investigation has ever been carried out.

Horowitz (1983) and Nikiforuk (1985) note that a disadvantage of salt fluoridation is the difficulty of controlling the distribution of salt of various fluoride concentrations, to accomodate varying levels of fluoride that occur naturally in water supplies. This may not be a problem in the Northwest Territories where most community water supplies have naturally occurring fluoride levels of less than 0.1 mg/L. In those communities where fluoridation of water supplies is practised or where the natural fluoride content of the water is high (e.g. Wrigley = 0,83 mg/L), the public must be advised that the consumption of fluoridated salt is not necessary (Toth, 1986). Even better, if possible, for fluoridated salt not to be delivered to such communities.

Piccard (1986) reports that salt consumption is very high among native people in the Northwest Territories. As a result of this, nutrition campaigns by Health & Welfare Canada stress the need for reduced salt intake, as it has been associated with hypertension, among other ailments. Thus, from a public health perspective, advocating the consumption of fluoridated salt would conflict with the campaign to reduce salt consumption.

4.2.3 Milk Fluoridation

The addition of fluoride to milk for general community use, or for use specifically in schools has been discussed by several authors (e.g. Horowitz, 1983). There are several advantages to milk fluoridation. There would be no wastage as currently occurs in water fluoridation, consumption would be voluntary, and the program would not require the presence of dental health personnel.

However, milk fluoridation as a public health measure has several drawbacks (Stamm, 1972 and Horowitz, 1983):

i) The amount of milk consumed by children is governed by their socio-economic status,

ii) Although the need for fluoride to prevent dental decay increases with age, the consumption of milk by children, unlike that of water, tends to decrease with age. This in turn reduces the long-term benefits of milk fluoridation,

iii) Fluoride ions in water provide a topical effect on the already erupted teeth as the water passes through the mouth. In milk however, fluoride is bound to the calcium and protein and provides no such topical effect.

Furthermore, some native people (both Indian and Inuit) suffer from a condition known as "lactose intolerance". Those unaccustomed to drinking milk may experience discomfort digesting it, due to a deficiency of the enzyme lactase which converts lactose (milk sugar) to lactic acid in the small intestine. If however, milk has been a traditional part of the diet, adequate lactase will be present in the digestive tract (H & WC, 1985).

Moisey (1986) estimates that 50-60% of native children in the Northwest Territories suffer from "lactose intolerance". The addition of lactase tablets to milk is often recommended, to provide the necessary lactase enzyme (Piccard, 1986).

Finally, the addition of fluoride to milk is considered an inferior method of supplying the fluoride necessary to prevent the occurrence of dental caries (Stamm, 1972 and Horowitz, 1983). Most clinical results to date have proven inconclusive due to small sample sizes and the short duration of the experimental periods. Horowitz (1983) recommends that more clinical studies must be done before the fluoridation of milk can be recommended as a caries-preventive measure.

4.3 Topical Fluoride Supplements

Topical fluoride supplements are applied directly to erupted teeth, and provide only local protection at, or near, the tooth surface. The benefits of topical treatments are generally short-lived, lasting only as long as the treatment continues. They are not nearly as effective as systemic supplements in preventing dental caries. They may be self-applied, or applied by a dental health professional.

Professionally applied fluorides are generally more concentrated than self-applied preparations. A variety of different fluoride

agents, vehicles, and techniques have been used to provide topical fluoride treatment. Popular fluoride agents include sodium fluoride, stannous fluoride, and acidulated phosphate fluoride (APF). Topical fluorides have been applied as aqueous solutions or gels, and as pastes or varnishes. Varnishes adhere to the teeth for longer periods than the other products, and thus provide increased opportunity for fluoride uptake by the surface enamel. These products may be applied using paint-on, spray-on, or tray techniques. Although such treatments provide some caries resistance, they are generally too expensive for most public health programs, because they require one-to-one attention.

Self-applied topical fluoride treatments usually involve the use of fluoride toothpastes (dentrifices), or mouthrinses. Studies have shown that regular toothbrushing with an approved fluoride product will reduce the incidence of dental caries by 20 to 25% (Horowitz, 1983). Toothbrushing should be encouraged by parents and should be regularly supervised in the home.

In contrast with toothbrushing, fluoride mouthrinse (FMR) programs are frequently based in schools. Numerous clinical trials have shown that regular (e.g. weekly or bi-monthly) mouthrinsing with a dilute fluoride solution will reduce the incidence of dental caries in children by about 35% (Horowitz, 1983). As mentioned previously, mouthrinsing is not recommended for children younger than 5 years, because of their tendency to

swallow the solution. As with other school-based programs, the success of FMR programs depends on the continued cooperation between public health and education personnel. It also requires the motivation and interest of those directly supervising the program.

5.0 WATER FLUORIDATION IN THE N.W.T.

5.1 The Current Situation

A variety of water supply and distribution systems are currently used in the N.W.T.. These systems have evolved in response to various physical,social and economic factors, as well as the varying levels of development in northern communities. The systems can be roughly classified in terms of supply, treatment and distribution, as follows.

(1) Communities with conventional water treatment facilities, and:
    (a) piped distribution, or
    (b) trucked distribution.

(2) Communities that practice water disinfection only, and have:

    (a) piped distribution, and:
        (i) year-round storage, or
        (ii) no year-round storage;

    (b) trucked distribution, and:
        (i) year-round storage, or
        (ii) no year-round storage, and:
            - truckfill station, or
            - no truckfill station.

(3) No service provided by GNWT (communities with less than 50 residents).

The water supply and distribution systems in each of the 63 communities in the N.W.T. are classified, as outlined above, in Figure 5.1.

The revised regulations of the N.W.T. (1980, No. 218; pursuant to the Public Health Act, 1985) recommend that community water

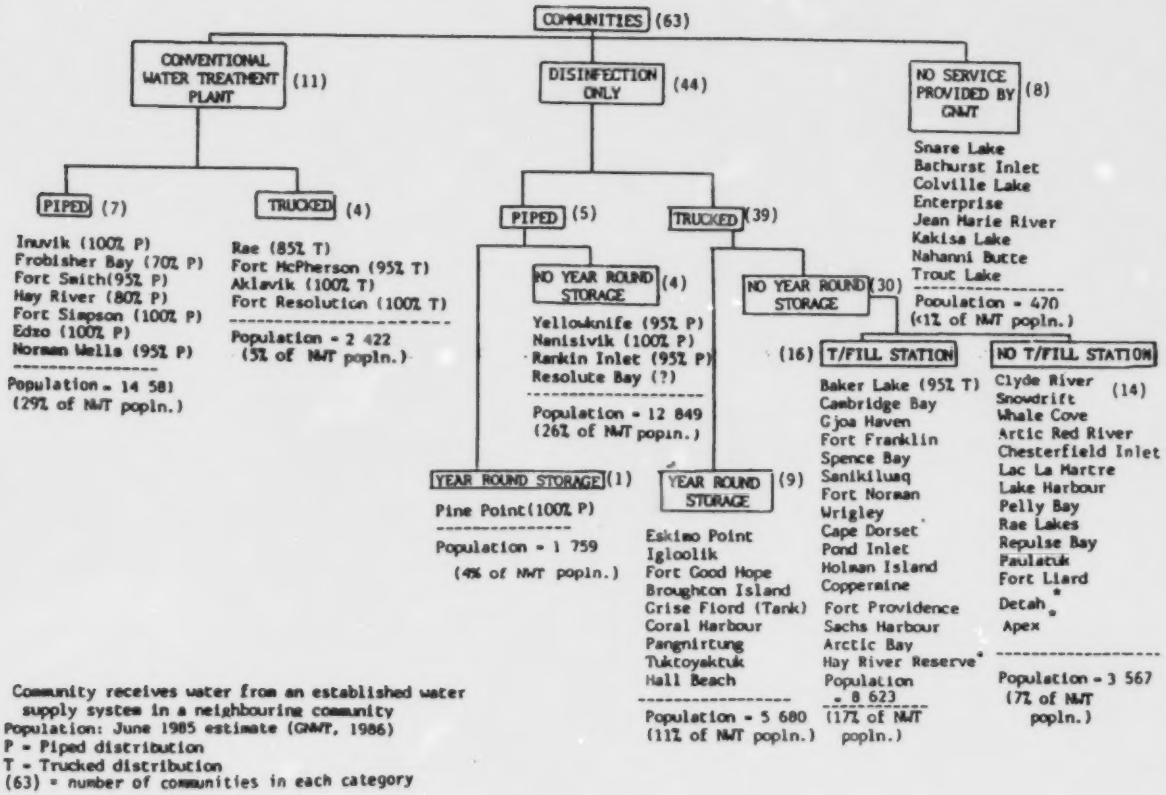


FIGURE 5.1

WATER SUPPLY & DISTRIBUTION SYSTEMS IN THE NORTHWEST TERRITORIES

supplies contain between 1.2 and 1.6 mg/l fluoride; with an optimum concentration being 1.4 mg/l. The natural fluoride content of fresh water in the N.W.T. is generally quite low (approximately 0.1 mg/l). Thus to achieve the optimum fluoride concentration of 1.4 mg/l, most communities would have to add fluoride supplements to their water supplies.

However, for a variety of reasons, only four communities (Fort Smith, Iqualuit, Inuvik and Yellowknife) currently practice water fluoridation. This is due, in part, to the diversity of supply and distribution systems mentioned earlier. Recommendations regarding water fluoridation in all of the remaining communities are presented in the following sections.

5.2 Fluoridation of Water Supplies

5.2.1 Conventional Water Treatment Plant

There are 11 communities in the Northwest Territories that have a water treatment plant. These communities comprise 34% of the population, but only three of them currently practice fluoridation, namely Inuvik, Iqaluit and Fort Smith.

Conventional water treatment generally involves the following processes.

(i) Coagulation and flocculation; which causes the small suspended particles to form larger aggregates (flocs).

(ii) Settling; of the flocs and other large particles.

(iii) Filtration; which uses granular materials (sand and gravel) to remove any remaining small suspended particles.

(iv) Disinfection; to kill disease-causing bacteria in the water.

As far as is practical, fluoride should not be added before the filtration process. Substantial losses of fluoride can occur, especially when alum is used for coagulation, or when the lime-soda ash process is being used. In either of these processes, fluoride is lost by precipitation or absorption on floc. Therefore, fluoride is usually added continuously to the filter effluent lines, or to a clear well, following treatment.

There are instances however, when it may become necessary to add fluoride before the filters, e.g. if the clear well is either inaccessible or located so far away from the plant that the transportation and handling costs of the chemicals becomes uneconomical.

Five of the 11 treatment plants in the N.W.T. are Waterboy WB-82 self-contained units, which include coagulation, flocculation, clarification (tube settling) and filtration stages. Discussions with the suppliers of the package units indicate that fluoridation could be incorporated in these units at a cost of approximately $5500 plus labour (Marianayagam, 1986). The use of

hydrofluosilicic acid is proposed instead of the dry fluorides because of convenience of handling.

In summary, the technology of water fluoridation in conventional water treatment plants is quite well-developed. Thus it should be relatively straightforward to implement fluoridation in the remaining 8 communities with conventional water treatment plants.

5.2.2 Disinfection Only, Year-Round Storage

There are 44 communities in the Northwest Territories, comprising 65% of the population, where disinfection is the only water treatment process necessary to produce potable water. Ten of these communities, with 15% of the population, have year-round storage capacity, but none currently practice fluoridation. Nine of the ten have a wholly trucked water distribution system. Only Pine Point has a fully piped distribution system. These water storage reservoirs are generally filled once each year (usually during the summer), and drawn down for the next 11 or 12 months.

Several options exist for the introduction of fluoride in a water supply system that incorporates year-round reservoir storage. These are discussed briefly below.

(a) Addition of fluoride as water is drawn from the reservoir. Several possibilities exist.

(i) **Meter a fluoride solution into the water on the discharge side of the distribution pump**, while filling the water truck tank or feeding the pipe network. The rate of injection of fluoride would have to be automatically proportioned to the water flow rate, by connecting a flow-measuring device to the fluoride metering pump.

Although chlorination systems are operated this way in many communities in the Northwest Territories, there are several drawbacks to this approach for fluoride addition. While an over-dosage of chlorine is readily detected by taste and/or odour, an overdosage of fluoride can not be detected without chemical analysis of the water. Thus, the control and maintenance requirements for fluoride systems are much more critical than for chlorination systems.

Such a fluoridation system would require a skilled operator, almost continuous attention and frequent monitoring of fluoride levels. The expected high operation and maintenance costs and the high turnover of staff in northern communities render this an unattractive option.

(ii) **Addition of fluoride in tablet form to the water truck tank where it would dissolve in the water.** Thorough mixing by means of a recirculating pump in the water truck tank would be essential for this system to produce satisfactory results. There are however, two major disadvantages. First, there is the possibility that the tablet may settle to a corner of the tank and not be affected by the mixing currents generated by the recirculating pump. This would lead to an uneven distribution of fluoride in the water, and result in some households receiving water with high levels of fluoride while others received very little. Secondly, a tablet that is meant to be added to a full water tank, may be added to a partially full water tank, producing undesirable fluoride concentrations.

(iii) **Pouring a quantity of fluoride solution into the water truck tank** (Grainge et al, 1968). Although a fluoride solution would likely mix more readily with water than a fluoride tablet, this approach also has several disadvantages. The fluoride solution would have to be accurately measured for each truckload of water. This would have to be done by the water truck operator, or pre-measured containers would have to be prepared in advance. In either case, one would have to assume that

the water truck was completely filled and completely emptied on each trip. This is often not the case.

Finally, there would be logistical problems in implementing such a program. The chemicals would have to be stored in a secure, warm place, where they would be accessible only to the water truck drivers. This would likely involve providing continuous access to the inside of the truckfill station; a potentially undesirable situation.

(iv) **Dissolution of fluoride tablets by water, as it flowed from the reservoir into the water truck tank** (Grainge et al, 1968). The tablets would be added to the supply line through a port and would be held in place by a sieve, inserted in the supply line. The sieve would be suitably sized to prevent the remnants of the disintegrating tablets passing through in sizes not easily dissolved, and at the same time not restrict the flow of water.

- As in the previous alternative, this assumes that the water truck tanks are completely filled and emptied on each trip; which may often not be the case. The number of tablets to be added would be dependent on the size of the tank. In many communities the water truck tanks

are of several different sizes. Thus, one could not be absolutely certain that each truck tank would receive the correct number of tablets, without frequent monitoring of fluoride levels.

For the above reasons, it is not recommended that fluoride be added as water is drawn from the reservoir.

(b) **Addition of fluoride to the reservoir after filling.**

If solid or liquid fluoride chemicals were added to the reservoir after it was filled, it would be difficult to achieve complete mixing. This difficulty would increase with the size of the reservoir. An incompletely mixed system would have areas of higher and lower fluoride concentration. This could potentially result in the domestic use of water with above optimum concentrations of fluoride, and should be avoided.

(c) **Addition of fluoride during the filling of the reservoir.**

In this system, fluoride would be injected into the reservoir influent line during the annual reservoir filling operation. The addition of fluoride during the filling of the reservoir is recommended for the following reasons:

(i) Thorough mixing of the fluoride chemical with the water would take place due to the turbulence in the supply

line between the point of injection and the storage reservoir;

(ii) The fluoridation of the water would be done once a year and thus would require skilled supervision for only a relatively short period of time, while the reservoir was being filled.

A complication of this system is the tendency for the fluoride concentration in the water to increase as ice forms during the winter. This phenomenon and its implications are discussed further in Chapter 6.1.3.

This "batch fluoridation" approach is therefore recommended in those communities with year-round reservoir storage. Because it is a new and innovative approach to water fluoridation, particularly appropriate for northern communities, it is discussed in more detail in Chapter 6.

5.2.3 Disinfection Only, No Year-Round Storage

There are 44 communities in the Northwest Territories, comprising 65% of the population, where disinfection is the only water treatment process necessary to produce potable water. 34 of these communities (including Yellowknife), with 50% of the population, do not have year-round water storage facilities.

Yellowknife, which accounts for almost 23% of the N.W.T. population, is the only community in this category that currently practices fluoridation. Of the 34 communities, 4 have a primarily piped distribution system, 16 are on a primarily trucked distribution system with truckfill station, and 14 communities have a trucked distribution system, but no truckfill station. Fluoride addition to each of these three types of systems is considered below.

(a) Piped Distribution

Four communities, namely Yellowknife, Nanisivik, Rankin Inlet and Resolute Bay practice disinfection only, and have primarily piped water distribution systems. Only Yellowknife currently practices fluoridation. The addition of fluoride to the remaining three systems is recommended only if the system configuration permits the effective monitoring of fluoride levels. The fluoride injection point must also be located so that the water to be fluoridated does not include water from a recirculation line.

Despite these constraints,fluoridation would appear to be feasible in all three communities. The use of a flow-proportioned metering pump is the most suitable means of adding fluoride. The rate of injection of the chemical can be automatically proportioned to the flow in the pipeline by connecting a flow-measuring device to the metering pump. A limitation of this

system is the need for a skilled operator and frequent (possibly daily) monitoring of fluoride levels.

(b) Trucked Distribution (with Truckfill Station)

16 communities possess no year round storage capacity and are on an almost wholly trucked water distribution system, from a truckfill station. As in the previous case, fluoridation is recommended only if the configuration of the water supply network permits the effective monitoring of fluoride levels. The fluoride injection point must also be located so that the water to be fluoridated does not include water from a recirculation line.

Again, a flow-proportioned metering pump would be the most suitable means of adding fluoride, although it may be difficult to identify an appropriate point of addition. It is not recommended that fluoride be added while filling the water truck at the truckfill station, for the reasons outlined previously.

Given these constraints, it is felt that fluoridation may be possible in 9 of the 16 communities in this category. The conceptual fluoridation proposals are outlined in Table 5.2.

(c) Trucked Distribution (no Truckfill Station)

Fourteen communities possess no year-round storage capacity, and are on an almost wholly trucked water distribution system,

TABLE 5.2

WATER FLUORIDATION RECOMMENDATIONS FOR

COMMUNITIES WITH DISINFECTION ONLY/NO YEAR-ROUND STORAGE/TRUCKED

DISTRIBUTION SYSTEM (TRUCKFILL STN.)

COMMUNITY	STATUS	POPU-LATION (GNWT'86)	EXISTING WATER SUPPLY FACILITIES	PROPOSALS FOR INCORPORATION OF FLUORIDATION
Baker Lake	H	1 003	Lake->pumps-8m^3 storage tank (internal) ->pumps->piped distn (5%) ->trucked distn (95%)	No recirculation in supply system. Fluoridate prior to 8m^3 storage tank. Monitor F levels at storage tank
Cambridge Bay	H	902	Lake->pumps->223m^3 insulated storage tank->pumps-> trucked distn	Recirculation in supply system. Fluoridate on line to 223m^3 storage tank. Monitor F levels in same tank
Gjoa Haven	H	663	Lake->pumps->11m^3 internal storage tank->pumps-> trucked distn	No recirculation in supply system. Fluoridate on line to 11m^3 storage tank. Monitor F levels in same tank
Fort Franklin	H	589	Lake->pumps ->trucked distn ->piped distn (few bldgs)	No recirculation in supply system. Fluoridate supply line to pump wet well. Monitor F levels in 68m^3 storage tank

TABLE 5.2 (CONTINUED)

COMMUNITY	STATUS	POPU-LATION (GNWT'86)	EXISTING WATER SUPPLY FACILITIES	PROPOSALS FOR INCORPORATION OF FLUORIDATION
Spence Bay	H	452	Lake->pumps-> heated 45,5m^3 storage tank-> pumps->trucked distn	Recirculation in supply system. Fluoridate on line to 45,5m^3 storage tank. Monitor F levels in same tank
Cape Dorset	H	837	Lake->pumps-> preheat unit-> 91m^3 storage tank ->pumps->trucked distn	No recirculation in supply system. Fluoridate on line to 91m^3 storage tank. Monitor F levels in same tank
Coppermine	H	887	River->pumps-> 409m^3 internal storage tanks (2 No.=409)-> trucked distn piped distn (wash house only)	No recirculation in supply system. Fluoridate on line to internal storage tanks. Monitor F levels in the same tank
Fort Providence	S	663	River->pumps-> softeners 18m^3 internal storage tank->pumps ->trucked distn ->piped distn (private system to 10 buildings)	No recirculation in supply system. Fluoridate on line to 18m^3 storage tank. Monitor F level in same tank
Sachs Harbour	S	161	Lake->pumps-> 10.5m^3 internal storage->pumps ->trucked distn ->piped distn (A.E.S.Bldgs only)	Recirculation in supply system. Fluoridate on supply line prior to recir-culation system. Monitor F levels 10,5m^3 storage tank (see Figure 14)

directly from the source. These communities currently possess no truckfill stations, but the Department of Municipal & Community Affairs, GNWT, expects to have truckfill stations in Snowdrift, Lac La Martre and Fort Liard in the near future (Michael, 1986). This has been completed for Snowdrift in 1987.

For reasons mentioned earlier, it is not recommended that fluoride be added during the filling of the water truck tank. Hence, water fluoridation in these communities is not feasible at this time. Alternative ways of augmenting the dietary fluoride intake of residents in these communities should be investigated.

5.2.4 No Service Provided by the Territorial Government

There are 8 settlements that comprise less than 1% of the population of the Northwest Territories, where no service is presently provided by the Territorial Government. These are unorganised communities (essentially large camps) where each household is expected to provide its own services. It is not feasible to consider water fluoridation at this level of sophistication of water supply. Alternative ways of augmenting the dietary fluoride intake of residents in these communities should be investigated.

5.3 Initiating Community Water Fluoridation

There are currently no programs aimed at promoting community water fluoridation in the N.W.T.. Many residents of northern

communities may be completely unaware of the benefits of fluoride supplements in general, or water fluoridation in particular. Any fluoride promotion programs are currently left to the discretion of dentists or dental therapists. In those communities with no resident dentist/dental therapist, there is little chance of fluoridation being promoted or implemented.

The practice of water fluoridation is an established preventive measure for reducing the incidence of dental caries, and is directly related to the improvement of dental health among residents of the Northwest Territories. As such, it is most appropriate that the initiative to establish water fluoridation in a community come from Medical Services Branch, Health and Welfare Canada, or from an equivalent G.N.W.T. department (once the devolution of health care responsibilities takes place in April, 1988).

Directives for the presentation of water fluoridation in a community should be established by Medical Services Branch, as soon as possible. During this process, close liaison should be maintained with municipal authorities. The Department of Municipal & Community Affairs, GNWT, is in a position to advise Medical Services Branch of those communities where water fluoridation is both safe and technically feasible.

Community councils may approve fluoridation administratively (i.e. by council motion), or they may opt for a plebiscite. If a

plebiscite is held, it is governed by rules and regulations under the N.W.T. Municipal Act. In either case, the proponents of fluoridation (Health and Welfare Canada, or G.N.W.T. staff), should provide as much information, advice and encouragement as possible. If a plebiscite is to be held, the information must be made available to community members in an easily understandable format. It would be particularly beneficial to involve as many local residents as possible in the information campaign.

6.0 BATCH FLUORIDATION OF WATER SUPPLY RESERVOIRS

6.1 Factors Affecting Batch Fluoridation

Adding fluoride to a water supply reservoir during the annual filling operation is conceptually very simple, but considerably more difficult in practice. Several complicating factors must be considered in designing a fluoridation system and in calculating the necessary fluoride dosage and feed rate. Some of these factors include: the reservoir layout, logistics and the freeze concentration of fluoride. Each of these is discussed further below.

6.1.1 Reservoir Layout

The reservoirs considered in this study have some similarities, and several differences. All of the reservoirs are filled once each year, generally in the late summer / early fall. In most instances the water source is some distance from the storage reservoir. Water is therefore pumped (or flows via gravity) through a pipeline from the source to the reservoir. The fill pumps (where used) are located at the water source and hence may be some distance from the reservoir. All of the reservoirs service a trucked water distribution system. Hence they all have a truckfill station, which houses the necessary equipment and instrumentation, near the reservoir edge.

Major differences between the reservoirs can be noted in: reservoir shapes and dimensions, location of the reservoir fill

(influent) lines, and location of the reservoir effluent lines (drawing from the reservoir). In most of the reservoirs, the reservoir fill line discharges over the edge of the reservoir berm. This line may discharge to air, with the water running down the side of the berm, or it may float on the rising water surface of the reservoir. An alternative arrangement found in Tuktoyaktuk and Fort Good Hope, has the influent line passing through the truckfill station and discharging at the bottom of the reservoir. In the first arrangement, the influent and effluent lines may be close together or far apart, while in the second arrangement, the influent and effluent lines are generally adjacent. The position of the influent line discharge will influence the mixing of the reservoir during filling.

Where the reservoir fill line passes through the truckfill station, access is available to the line for fluoride injection. In this instance, the truckfill station provides a secure, sheltered, climate controlled environment in which to set up equipment and store chemicals. This is not possible when the influent line discharges over the reservoir edge, generally some distance from the truckfill station.

6.1.2 Logistics

Design and implementation of projects in the north can be greatly complicated by numerous logistics problems. Some of these must be considered in the design of a batch fluoridation system.

First, one must consider the availability, transportation and handling of fluoride chemicals. Hydrofluosilicic acid (HFSA) is recommended over sodium fluoride or sodium silicofluoride, since it does not require mixing on site. Mixing powdered chemicals is potentially hazardous and requires some degree of skill. Operators with sufficient skill to manage the operation may not be available in many communities.

The acid is available from chemical suppliers in several locations in Canada, including Edmonton, Montreal and Toronto. Since HFSA must be transported by truck, rail or ship (not by air), shipments must therefore be arranged well in advance to ensure delivery at the necessary time. Hydrofluosilicic acid is generally sold in 140 kg barrels (approximately 25 Imp. gallons). It may be very difficult to handle such heavy containers, particularly if lifting equipment is not available. Thus, it may be advisable to arrange for purchase and shipment of the acid in smaller, more easily handled containers (eg. 5 or 10 gallons). Arrangements must also be made to store the acid once it arrives in the community. It may be necessary to store surplus and/or partly full containers from one year to the next.

The acid will be fed into the reservoir fill line using a variable flow metering pump. Such pumps require 110 volt AC power. Hence, an appropriate power supply must be available at, or near the point of fluoride injection. Arrangements should

also be made for pump repair or replacement services. Because of the difficulty of site repair work in remote locations, it may be advisable to keep several back-up pumps available in some central location (eg. Yellowknife or Iqaluit). These could be shipped to a community, as needed, on relatively short notice.

Finally, it is desirable to be able to monitor the fluoride concentration in the reservoir during the filling operation. The necessary laboratory facilities are available in very few locations in the N.W.T. The time necessary for sample transportation and analysis is likely in the order of several days. Because more rapid feedback regarding fluoride concentration is desirable, a portable fluoride analysis kit, for on-site use, is recommended. Such kits are available from the Hach Chemical Co. (and other suppliers) and are relatively straightforward to use.

6.1.3 Freeze Concentration of Fluoride

Observations of natural systems and considerable experimental work (eg. Fertuck, 1968 and 1969) indicate that most ions are rejected from freezing water, producing ice which is relatively pure. The more slowly ice is formed, the more efficient this process becomes. The net result of this "freeze concentration" phenomenon is that ions become concentrated in the water remaining below the ice.

Thus, if fluoride is added to reservoir water once each year, (generally in late summer / early fall) its concentration will increase as the reservoir freezes. One must ensure that the initial (full reservoir) fluoride concentration does not produce a concentration, in the unfrozen portion of the reservoir, above the recommended maximum of 1.6 mg/l, under maximum expected ice conditions.

6.2 Information Requirements/Calculations

The previous section described several factors which must be considered in designing a fluoridation system, and calculating the appropriate initial fluoride concentration. The subsequent section will outline the design of two fluoridation systems. The information and calculations required to determine the fluoride dosage are summarized below. These steps are illustrated in some detail in a report by Murray and Heinke (1988).

(1) Determine the current fluoride concentration in the reservoir, and in the water source (i.e. from which the reservoir is filled).

(2) Determine, from as-built drawings and design reports, the reservoir dimensions, cross section, etc. Use these to develop water depth versus surface area and water depth versus reservoir volume relationships.

(3) Determine the average monthly water consumption from the reservoir. This may vary considerably from month to month.

(4) Calculate monthly ice growth. Several methods are outlined by Murray (1987).

(5) Perform dynamic drawdown analysis to determine the expected reservoir volume in each month.

(6) Determine the appropriate initial (full reservoir) fluoride concentration, so that the maximum fluoride concentration (expected in late Spring) does not exceed the permissible concentration of 1.6 mg/l.

This information was collected, and these calculations performed for eight N.W.T. communities in a report by Murray (1987). Readers interested in the details of batch fluoridation should refer to that report.

6.3 Conceptual Design of Batch Fluoridation Systems

The batch fluoridation system design follows that presented by Marianayagam (1986). In essence, the system consists of a variable flow rate pump which feeds hydrofluosilicic acid from a shipping container or feed tank into the reservoir influent line during reservoir filling. In this way, fluoride is added to, and mixed intimately with, all of the water entering the reservoir. The mixing of the influent with water already in the reservoir will be determined by other factors, as mentioned previously.

The HFSA should only be injected into the influent line when the reservoir is actually filling. Mechanical problems such as pump failure, line break etc. resulting in loss of influent flow are sometimes encountered during reservoir filling. To prevent

feeding HFSA during periods of no flow, a flow switch is included in the system. This device senses flow/no-flow conditions, and switches off the power to the fluoride feed pump in the event of a no-flow condition.

The basic conceptual design is affected by the layout of the reservoir influent line. In those installations where the influent line passes through the truckfill station, the necessary equipment can be set-up inside the truckfill station. However, in most cases, the influent line discharges directly to the reservoir side or surface and does not pass through the truckfill station. An alternative design is required in this case. Conceptual designs for both alternatives are presented in the following sections.

6.3.1 Indoor Fluoridation System

Where the reservoir influent line passes through the truckfill station, all the equipment can be set up securely inside the truckfill station. The indoor fluoridation system is illustrated schematically in Figure 6.1. This system is recommended for use in Tuktoyaktuk and Fort Good Hope. As indicated, the acid is pumped from a feed tank into the influent line. The feed tank is not essential, since HSFA could be fed directly from the shipping containers into the influent line. However, if HFSA is supplied in small containers, it may be more convenient to transfer the

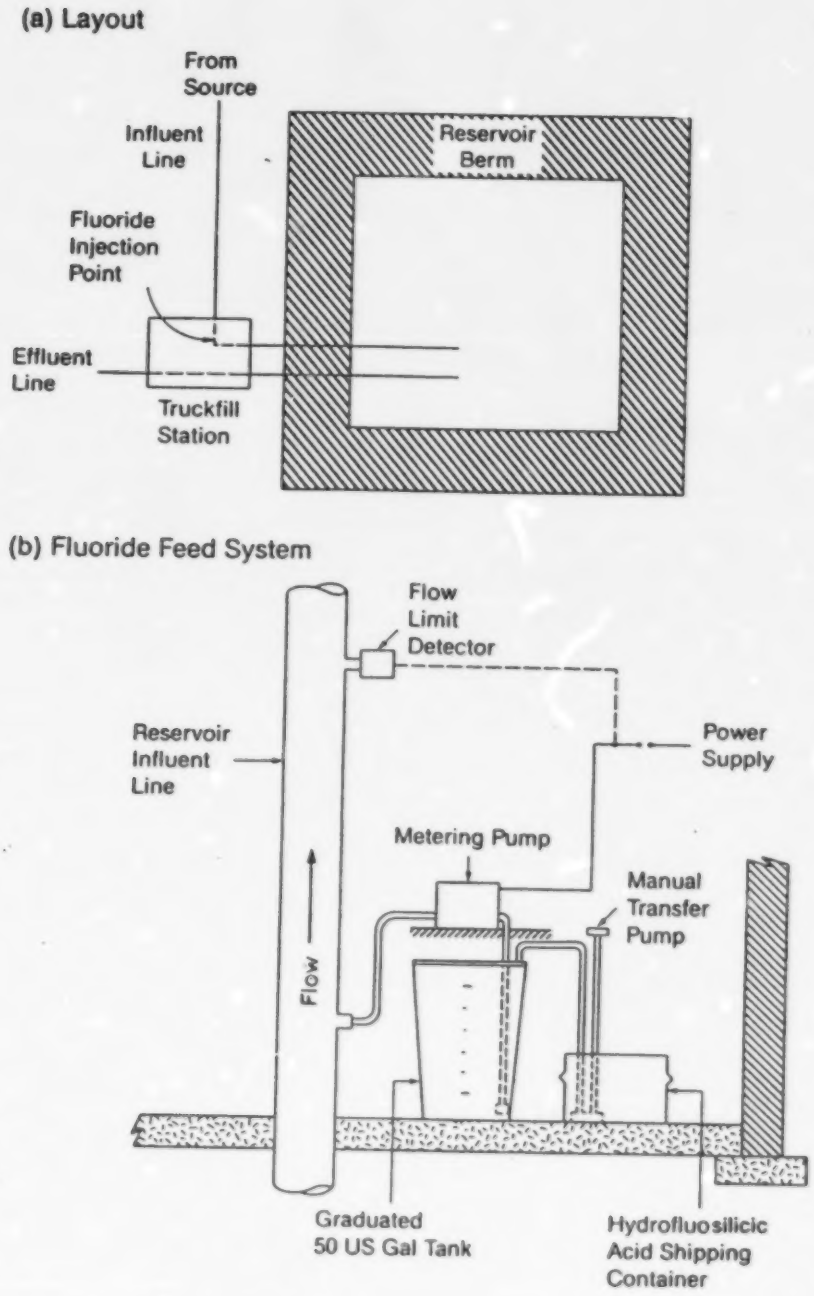


FIGURE 6.1

INDOOR FLUORIDATION SYSTEM

acid into the feed tank, to avoid having to change the feed container frequently. In any case, the feed tank is constructed of clear plastic, which permits visual monitoring of the volume of acid added to the reservoir. This provides a quick, although not very accurate, check on the acid volumetric feed rate.

The system is designed to avoid feeding fluoride if the influent flow stops for any reason. Finally, provision is made for a sampling point, downstream of the fluoride injection point. This feature is not essential, but is recommended to facilitate the monitoring and control of the fluoride addition.

6.3.2 Outdoor Fluoridation System

Design and implementation of batch fluoridation is somewhat more difficult when the reservoir fill line does not pass through the truckfill system. In this case, there are several possible fluoridation alternatives, including:

(1) Install fluoridation equipment along with the reservoir fill pump at the water source. However, these locations are often difficult to access, and very rarely have an appropriate power supply.

(2) Install fluoridation equipment inside truckfill station: run the fluoride pump discharge line along the reservoir edge to an injection point in the influent line. However, both the feedback from the flow switch (which would be installed on the influent line), and the fluoride pump discharge line

would be exposed for a considerable distance. Although reservoirs are generally enclosed by a fence, there is the possibility of these lines being disturbed (by small ground animals etc.). Interruption of the flow switch signal would not be particularly serious, but a break in the fluoride line might have undesirable consequences.

(3) Install fluoridation equipment on the edge of the reservoir, adjacent to the influent time, as it enters the reservoir. Power to this installation would have to be supplied from the truckfill station by a temporary power line laid on the ground. This power line would be vulnerable to the same disruption mentioned above. The equipment, and chemical feed tank could be housed in a small locked enclosure, on the edge of the reservoir.

Of the three alternatives, the first is not promising because of the power supply problem. Both the second and third have some merits, as well as disadvantages. The third alternative (equipment installed at the reservoir edge) is preferred, because only the power line must be laid on the ground between the influent line and the truckfill station. A schematic illustration of such an outdoor fluoridation system is presented in Figure 6.2. This system is recommended for use in Pangnirtung, Broughton Island, Igloolik, Eskimo Point, and Coral Harbour. Grise Fiord requires a unique system, as described by Murray (1987).

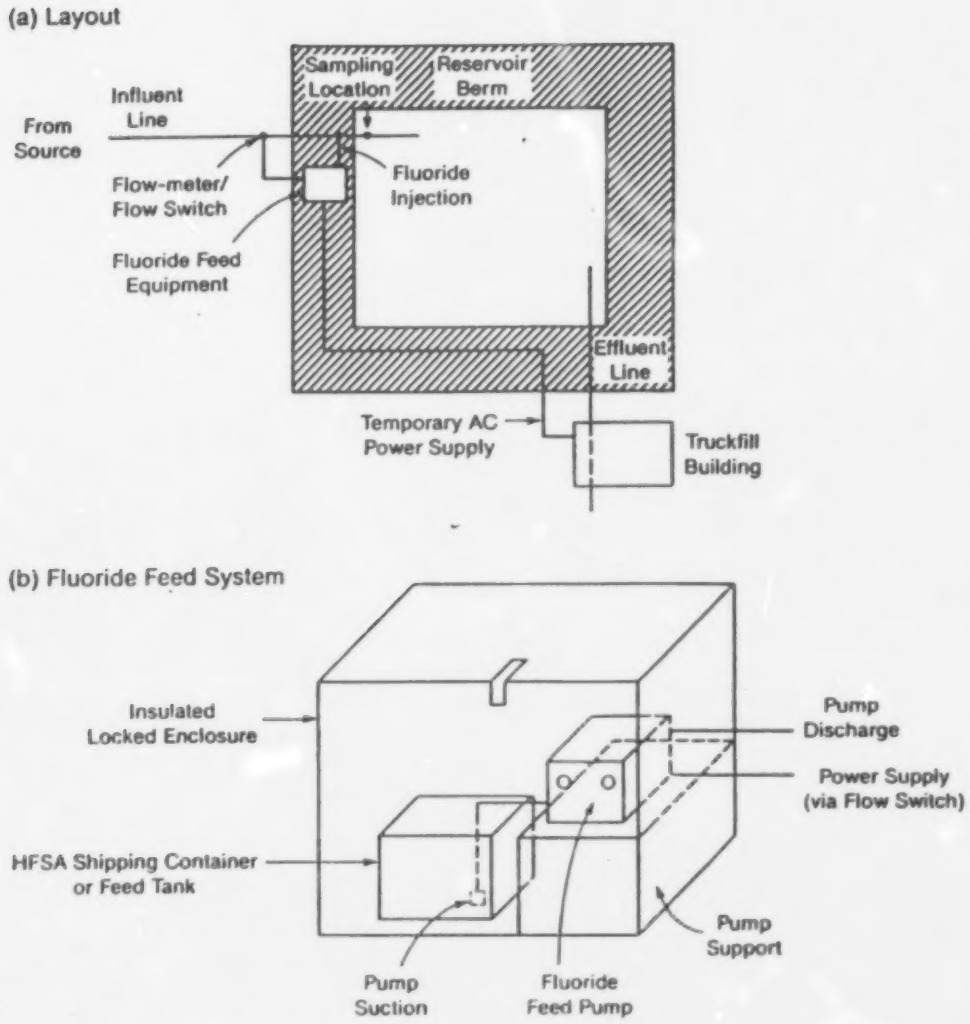


FIGURE 6.2

OUTDOOR FLUORIDATION SYSTEM

As indicated in Figure 6.2, all of the fluoridation equipment would be housed in a locked enclosure. The enclosure should be waterproof, but does not have to be heated. Although freezing conditions are not expected in late summer / early fall, it might be prudent to insulate the enclosure. The enclosure would house an acid feed container (5 to 10 gal. size), the fluoride injection pump, and any necessary instrumentation for the flow switch.

6.4 Implementation of Batch Fluoridation

Marianayagam (1986) recommended Tuktoyaktuk as a potential site for the first application of batch fluoridation. In April, 1987, the Hamlet council authorized the fluoridation of Tuktoyaktuk's water supply reservoir. This provided an opportunity to demonstrate the technology of batch fluoridation. The fluoridation of the Tuktoyaktuk reservoir is described in detail by Murray (1987), and summarized below.

The current water supply system in Tuktoyaktuk was completed in late 1985. It consists of an intake and pumping unit at the source (Kudulak Lake), a supply pipeline to the water storage reservoir, and a truckfill station and pump service building adjacent to the reservoir. Several of these components are illustrated schematically in Figure 6.3 (a). The reservoir is a circular, lined structure constructed from sand dredged from Tuktoyaktuk harbour. It is filled in late summer/early fall each

year from Kudulak Lake. This water has a fluoride concentration of 0.1 mg/l (Marianayagam, 1986). The portable pumping unit at the lake has a capacity of approximately 1 million Imperial gallons per day (52.5 l/s) (Reagan, 1987).

As outlined previously, the calculation of the required fluoride supplement involved the following steps:

- determine the fluoride concentration of the water in the reservoir,
- determine the fluoride concentration of the water to be used to fill the reservoir,
- determine monthly water consumption,
- determine reservoir volume prior to filling,
- calculate expected monthly ice growth,
- determine depth/area/volume relationships from reservoir dimensions,
- calculate the expected monthly reservoir volumes (i.e. reservoir drawdown),
- perform iterative fluoride freeze concentration calculations to determine the highest full reservoir fluoride concentration which will not produce a maximum (late spring) fluoride concentration above 1.6 mg/l, and
- determine the fluoride supplement, and feed rate necessary to reach the desired fluoride concentration.

These calculations are summarized in the report by Murray and Heinke (1988).

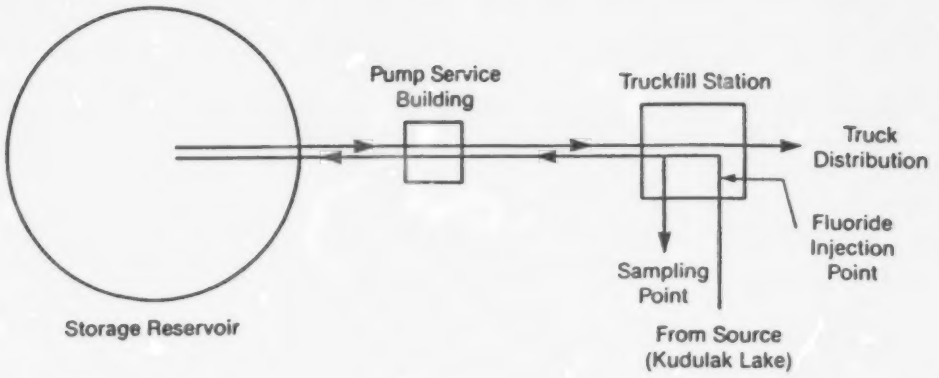
The calculations indicated that the reservoir should be fluoridated to a concentration of 0.8 mg/l. Allowing for the freeze concentration effects, it was estimated that this would produce a maximum (late spring) fluoride concentration between 1.46 and 1.57 mg/l (depending on water consumption).

6.4.1 Fluoridation System

Hydrofluosilicic acid (HFSA), as a 25% solution (by weight), was used as the source of fluoride ion. The fluoride was injected into the reservoir fill line inside the truckfill station, as indicated in Figure 6.3(a). The feed system is illustrated in more detail in Figure 6.3(b). The acid was first transferred from the shipping containers to the graduated plastic drum, using a manual acid transfer pump. The feed pump then drew the acid from the plastic tank and injected it into the 250 mm diameter fill line. The feed pump was a Wallace and Tiernan Series 45 Chempulse pump. It had a manually controlled, variable discharge rate, with a maximum capacity of 1 US gallon per hour, and a maximum discharge pressure of 150 psi.

The fluoride solution was added fairly continuously during the reservoir filling. The filling operation took approximately 15 days, and fluoride was added over 10 days.

(a) Schematic Layout



(b) Acid Feed System — Truckfill Station

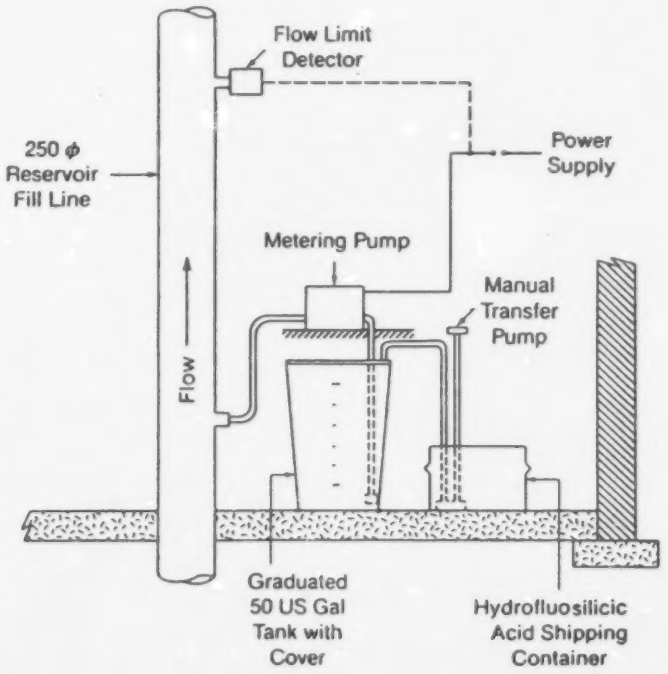


FIGURE 6.3

TUKTOYAKTUK FLUORIDATION SYSTEM

The feed system was designed to avoid feeding fluoride if the reservoir fill pump stopped for any reason. A non-invasive sonic flow switch was used to sense flow/no flow conditions. If theflow in the fill line stopped, the flow switch would automatically cut off the power supply to the fluoride feed pump.

The reservoir fluoridation proceeded quite smoothly. With minor exceptions, the equipment functioned as expected, and produced the expected results. A routine monitoring program is now in place which will facilitate the comparison of actual observations with predicted values (e.g. ice growth, fluoride concentrations etc.).

7.0 SUMMARY OF RECOMMENDATIONS

A number of recommendations were made throughout this report. These are summarized below.

(1) Comprehensive Data Baseline Survey & Follow-up Surveys on Dental Health

These are of the utmost importance to evaluate the impact of present dental delivery systems, health education programs, and preventive and treatment services.

It is recommended that:

A comprehensive data baseline survey across the Territories be established, and regular follow-up surveys to include indices of oral health and treatment needs be conducted.

(2) Preventive Dental Programs

Dental services currently being provided by Medical Services Branch are almost wholly treatment oriented. It has been established that no preventive fluoride supplement programs are conducted for children from just after birth until they start attending school, where they may or may not receive the benefits of mouthrinse programs. Greater emphasis must be placed on the implementation of preventive programs.

It is recommended that:

a) **School-based preventive programs currently being implemented from grade 1 onwards, commence a year earlier at the kindergarten level;**

b) Investigations be conducted on the feasibility of instituting fluoride supplement programs in well-baby clinics and daycare centres.

(3) Incorporation of Dental Health Programs in the School Curriculum

No time is officially allocated in the current Department of Education school curriculum for dental health education and preventive programs, conducted by dental therapists. School officials are therefore under no obligation to incorporate dental health programs in the school curriculum.

It is recommended that:

Preventive dental strategies such as fluoride mouthrinse/tablet programs, and dental health education be incorporated as part of the school curriculum of the Territorial Department of Education, from kindergarten upwards.

(4) Dental Therapy Program

Resident dental therapists are essential to maintain the continuity of preventive programs. The National School of Dental Therapy in Prince Albert, Saskatchewan could graduate approximately twice as many dental therapists each year, given additional funding.

It is recommended that:

The Dental Therapy program be expanded and more dental therapists be placed in the Northwest Territories.

(5) Presenting Fluoridation to the Community

The presentation of fluoridation to a community is currently left to the discretion and initiative of the resident dental therapist or dentist. In the event of a plebiscite, efforts must be made to raise the level of awareness of the community as a whole, through presentations, seminars, use of appropriate audio-visual aids, etc.

It is recommended that:

Medical Services Branch develop specific directives for the presentation of fluoridation to a community.

(6) Dental Health Education and Promotion Materials

It is recommended that:

Appropriate dental health education and promotion materials for native people continue to be developed, especially in dialects which can be understood, reflecting the culture, lifestyle, values and identity of the native people.

(7) Tea as a Source of Fluoride

It has been established that tea contains high fluoride levels regardless of whether the water used in brewing is fluoridated or not.

It is recommended that:

a) **Parents and elders in the communities be advised that the traditional practice of drinking tea is beneficial to the strengthening of tooth enamel;**

b) **Parents be encouraged to impart the practice of tea-drinking to the younger generation.**

(8) Fluoridation of Community Water Supplies

Given that water fluoridation is the most equitable efficient and effective means of providing fluoride supplements to a community, water fluoridation should be practiced as widely as possible in the N.W.T. Implementation of the recommendations below would increase the benefits from fluoridated water from 4 communities currently to 34 communities. For the remaining 29 communities, most of which are small, methods of providing a fluoride supplement other than through public water supply can be considered.

It is recommended that:

(a) Fluoridation of community water supplies be implemented in those communities where this study has deemed it to be technically feasible and safe.

(b) Further, detailed studies be done regarding fluoridation in communities with partial water treatment (disinfection only) and no year-round storage.

(9) Administration of Fluoridation Programs

This study has indicated that water fluoridation is technically feasible in many communities. The remaining constraints to successful fluoridation programs are therefore primarily administrative.

It is recommended that:

The N.W.T. government resolve the administrative responsibilities for future fluoridation programs. Responsibilities should be clearly defined, and assigned to specific groups or individuals.

8.0 REFERENCES

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